Chapter 5.
Pioneering a New Course, 1945–1947

If our future standards of living are not to be lowered painfully, if victory is not to cost us the progress of generations, this Government must take the lead in all steps that will restore and promote the development of our natural resources. It must foster and support the labor and ingenuity of scientists and technicians who can pioneer our course to new sources and uses of materials and power.[1]

—Oscar L. Chapman

The United States emerged from World War II as the strongest nation in the world, even though its efforts toward winning the war cost $330 billion. Harry Truman asserted on September 1, 1945, that the United States held "the greatest strength and the greatest power which man has ever reached."[2] The President emphasized in an earlier speech that "[w]e all have to recognize—no matter how great our strength—that we must deny ourselves the license to do always as we please."[3] Winston Churchill observed on March 5, 1946, that the United States was now the world's premier power, but with that power, he cautioned, came a profound responsibility to future generations.[4] During the war years, the United States doubled its national income, wealth, and industrial production. U.S. steel output, a key indicator of industrial strength, reached in 1944 a level more than four times larger than those of the depression years, while wartime damage and scarce capital crippled the steel industries of Britain, the Soviet Union, and countries in northwestern Europe and destroyed those of Germany and Japan. The United States, to maintain its leading position, needed to increase rather than just conserve its existing resources in industrial plants, land, monetary reserves, power, raw materials, and scientific talent. The results of a comprehensive appraisal of U.S. mineral resources, begun in 1944 by the U.S. Geological Survey (USGS) and the U.S. Bureau of Mines (USBM), indicated a generally favorable outlook for minerals, but resources for several of those commodities remained deficient in quantity and (or) grade. The two agencies recommended a dynamic program of research and exploration to supply current and future needs.

The USBM and the USGS expanded significantly their funding, staffs, and operations in the war years. Between fiscal years 1939–40 and 1945–46, the USGS more than doubled its available funds to $15.1 million, of which $7.4 million represented direct appropriations. Transferred and repaid funds declined only from 52 to 51 percent of the agency's total monies. During the same years, the USGS nearly doubled its personnel; the agency's regular, or nonseasonal, staff increased from 1,472 to more than 2,490 scientists, engineers, and supporting persons. Although Fritiof Fryxell and other specialists employed by the USGS for the emergency returned during fiscal year 1945–46 to their career commitments in academia or industry, or resumed their formal education, Frank Whitmore, Jr., and others chose to stay on with the USGS. Fryxell and other war-service departees did continue part time with the agency via the long-established salary arrangement of "when actually employed."

To meet the increasing postwar demands for trained geologists, the USGS began early in 1946 a cooperative program with six universities—Chicago,

Columbia, Harvard, Johns Hopkins, Princeton, and Yale—that gave supervised all-around training to those near-graduate, graduate, or postgraduate American geologists who served in the armed forces without gaining therein any significant professional experience. The Geologic Branch designed the temporary appointments of qualified discharged veterans to help them adjust rapidly and well while resuming their careers and asked those interested to apply to Chief Geologist Wilmot ("Bill") Bradley.

When the Japanese surrendered on September 2, 1945, the United States and its new President faced major continuing and new problems at home and abroad. The Nation's more widely perceived domestic difficulties, like those after World War I, involved fears of widespread unemployment, rising prices, housing shortages, and inflation. Labor unions, determined to prevent a recurrence of the setbacks they experienced after 1918, encouraged nearly 500,000 workers to strike once the war terminated. By the end of 1945, large-scale walkouts in several leading industries seriously curtailed production throughout the country. In addition, relations between the free world and the Soviet Union demanded increased attention, and, if possible, resolution. U.S. exchanges with the Soviets during the war were based on military necessity, but the conflict ended without a clear consensus in the U.S. Government about postwar relations. Some people believed that the United States and the Soviet Union could work together to establish a global-security system to prevent future wars; others saw the Soviets firmly committed to an unlimited expansion that the United States and her Western European allies must resist in trying to restore a worldwide balance of power.

In 1945, Joseph Stalin's Soviet Union could look back on nearly 500 years of intermittent Russian and Soviet expansion. At the end of World War II, Soviet contiguous territory stretched across 45 degrees of latitude and 165 degrees of longitude and embraced 11 time zones. The Soviets also occupied, dominated, or influenced additional areas westward (except for West Berlin) to the Elbe (the farthest west since 1814) and the Kaliningrad region annexed from Germany and Lithuania, north to Finland, southwest to Yugoslavia and Greece, south to Turkey, Iraq, Iran, and Afghanistan, southeast to China and the northern half of the Korean Peninsula, and northeast to Chukotka, Big Diomede Island in the Bering Strait, and the Komandorskiye (Commander) Islands west of the Aleutians. The Soviet Union aided Communist Parties trying to gain control of Greece, Italy, France, and other European nations as yet unoccupied by Soviet forces and helping indigenous peoples in Asia to overcome attempts by the West's colonial powers to reassert their rule. The West's rapid postwar demobilization gave the Soviets a huge advantage in ground forces, but to project power effectively beyond Eurasia, they needed nuclear weapons, long-range bombers and ballistic missiles, and a blue-water navy.

The Soviet Union's neighbor China remained divided by internal strife,[5] but Generalissimo and President Chiang Kai-shek and Chairman Mao Tse-tung (Mao Zedong) began negotiations on August 26, 1945, to try to resolve their differing views of their country's future and their respective roles in it. The two leaders did so in the light of the treaty of friendship and alliance between Nationalist China and the Soviet Union signed in Moscow on August 14 by Soong Tse-ven (Soong Tzu-wen), the Harvard-educated financier and older brother of Madame Chiang, who, since 1925, served Chiang as minister of finance, foreign minister, and now premier. The treaty made Dalian (Dalny or Dairen), the terminus of the South Manchuria Railway, a free port but leased half of its facilities to the Soviets and gave them joint use of the naval base at Port Arthur (Lüshun) that they held between 1898 and 1905. Chiang and Mao reached an uneasy truce on October 11, but their struggle to control Manchuria, as the Soviets withdrew, resumed later that month.

On September 2, as Chiang and Mao discussed Manchuria and other pressing issues, and the Japanese surrendered to the Allies, Hõ Chí Minh's Viet Minh,

Harry S. Truman (1884–1972), the 33d President of the United States (1945–53), led Battery D of the 129th Field Artillery Regiment in combat in France during 1918. Truman served as an elected judge of Missouri's Eastern District (1922–24) and Jackson County (1926–34), U.S. Senator (1935–45), Chairman of the U.S. Senate Special Committee to Investigate the National Defense Program (1942–45), and Vice President of the United States (1945). He succeeded Franklin Roosevelt as President after Roosevelt died in April 1945. Truman made the final decision to use the atomic bomb against Japan to end World War II, introduced the domestic Fair Deal, desegregated U.S. armed forces, promulgated the Truman Doctrine, approved the Marshall Plan and the Point Four Program, established the Department of Defense, authorized the U.S. military response to the invasion of South Korea, sent to the Senate the peace treaties with Germany and Japan, and supported the United Nations. Truman, although exempt from the term restrictions required by Article XXII of the Constitution in 1951, chose not to run for reelection in 1952. (Photograph from the Library of Congress, Prints and Photographs Division, 3b45707.)

the League for the Independence of Vietnam, declared the free and independent Democratic Republic of Vietnam, with its capital at Hanoi, Hõ as its president, and Võ Nguyên Giáp as its interior minister. Hõ cofounded the Communist Party of France, trained in Moscow, and served in China, where American influence freed him from Chiang's forces in 1943. His troops, organized in 1944 by Giáp, a former lawyer and history teacher turned military strategist, fought the Japanese in Tonkin, aided from July 1945 by a few American advisers and modest amounts of American equipment and supplies from Nationalist China. Hõ now appealed directly to President Truman and Secretary of State James Byrnes to recognize his government, but Hõ received no reply, even though he based his country's declaration of independence from France on America's from Britain.

Vietnam had endured many intervals of union and division. The Empire of Annam, founded in 1802 at Hue, comprised the principal administrative regions of Tonkin (northern), Annam (central), and Cochin China (southern). The French established authority over these three regions and adjacent Cambodia by conquests and treaties between 1862 and 1887, the year the French Government joined the four regions in its Union of Indochina, under a governor-general at Hanoi. The French added Laos to the Union in 1893. The Japanese restored the Empire of Annam, under Bao Dai, during 1941–45. By the Allied agreement at Potsdam, Japanese units in Indochina surrendered to British troops south of the 16th parallel and to French forces north of that line. Bao Dai abdicated, and the French returned to Saigon in force early in October 1945 and then occupied most of Cochin China. To discuss these and related issues, including a U.N. trusteeship for Korea (temporarily divided along the 38th parallel), the proposed joint American-British-Chinese-Soviet administration of Japan, the pending peace treaties for the European Axis Nations, and the international control of nuclear energy, the Council of Allied Foreign Ministers met in Moscow (as planned) during December 16–26.

On March 6, 1946, the French recognized Hõ's Republic as a free state within their Indochinese Federation and the wider French Union, agreed to stay while the Nationalist Chinese left, and to withdraw their own forces by 1952. Meanwhile, the French continued to increase their land, air, and naval units in Indochina. On June 1, the French established the Republic of Cochin China. Hõ's talks at Paris in July and August failed to yield true political independence for the Viet Minh alliance or his requested referendum to unite Vietnam. After French warships bombarded Hanoi's port of Haiphong on November 23, killing 6,000 people, Hõ again appealed (unsuccessfully) to the United States. He then called for national resistance but fled Hanoi on December 21. The French captured the city and the anthracite coals near the port of Quang Yen, 10 miles to the northeast. From their old bases in Tonkin's highlands beyond the Red River Delta, Viet Minh troops, operating under Giáp, and with additional aid from Mao's forces, began a guerrilla war as the initial phase in ousting the French.[6]

In U.S. postwar foreign and domestic affairs, the role of science and technology also became an issue. Truman's Executive order of June 8, 1945, provided for the release of scientific information,[7] with certain exceptions, and a subsequent order on August 25 extended access to include the scientific and industrial information gained from the Axis Powers.[8] The establishment of an organization to continue work in nuclear energy, as Truman promised, seemed inevitable. Support for research by the U.S. armed services along the lines of their own special interests appeared almost equally certain. Most of the scientific studies conducted during the war involved applied work, drawing in part on earlier basic research. To what extent should, or would, the Federal Government support basic research in the postwar world?

The U.S. Government considered to some degree all of these problems before the war ended, as it prepared an orderly transition to peace, but the executives all but abandoned planning in the abrupt ending of the conflict. On August 16,

1945, the day after Victory over Japan (V–J) Day celebrations, President Truman announced the lifting of most economic controls, except those required for a smooth transition to peacetime conditions. On the 18th, Truman issued an Executive order directing all Federal agencies "to move as rapidly as possible without endangering the stability of the economy toward the removal of price, wage, production and other controls."[9] Julius Krug, Chairman of the War Production Board (WPB), responded by revoking 210 orders that restricted production of household appliances, causing his Vice Chairman, Professor William Y. Elliott of Harvard, to resign in protest. As the WPB removed its controls over industry, the Government canceled $35 billion in war contracts and offered for sale both Army and Navy surplus goods. The United States terminated its Lend-Lease Program on August 21 and began an immediate demobilization of U.S. armed forces. Executive orders issued during August 31–October 4 abolished the Foreign Economic Administration;[10] the Office of Censorship; the Office of Economic Stabilization, reestablished on February 21, 1946; the Office of War Information, the WPB, effective November 3; and the War Refugee Board. On January 4, 1946, Truman ordered the Office for Emergency Management to direct the liquidation of the remaining war agencies.

On September 6, 1945, only 4 days after the Japanese surrendered in the formal ceremony, the President sent to Congress a 21-point message about reconversion that called the legislators' attention to the Nation's experience in national reconversion and recovery after World War I. "We must be sure this time," Truman emphasized, "not to repeat that bitter mistake."[11] His legislative proposals included bills for full employment, unemployment compensation, an increased minimum wage, comprehensive housing, protection and encouragement for small businesses, permanent price supports for farmers, and grants for hospital construction. The President also added recommendations for increased public works for discovery, development, and conservation of natural resources and the establishment of a single Federal agency to direct and fund scientific research. With regard to the latter, Truman said that

> **[n]o Nation can maintain a position of leadership in the world of today unless it develops to the full its scientific and technological resources. No government adequately meets its responsibilities unless it generously and intelligently supports and encourages the work of science in university, industry, and its own laboratories.[12]**

In recommending a single Federal research agency, the President endorsed the concept of an interrelated and cooperating system of academia, industry, and government that Vannevar Bush, as head of the Office of Scientific Research and Development (OSRD), introduced in his new "Science—The Endless Frontier." In that report, Bush and his team addressed the four topics of concern listed in the letter that Bush received from Roosevelt in November 1944 and evaluated by Bush's four "distinguished committees specially qualified to advise in respect to these subjects."[13] Walter W. Palmer, Bard Professor of Medicine at Columbia and Director of Medical Services at New York City's Presbyterian Hospital, headed the Medical Advisory Committee, which included seven professor-practitioners of medicine and Caltech's chemist Linus C. Pauling. Geographer Isaiah Bowman, still serving as president of Johns Hopkins University (JHU), chaired Bush's Committee on Science and the Public Welfare, which comprised physicist Isidor Rabi (who had worked at the Radiation Laboratory at the Massachusetts Institute of Technology [MIT's Rad Lab] and on the Manhattan Project), USGS Director William Wrather, and 14 other members drawn from academia, the Federal Government, industry, the Brookings Institution, and the Rockefeller Foundation. Henry A. Moe, the Guggenheim Foundation's Secretary-General, led the Committee on Discovery and Development of Scientific Talent that included James Conant and 12 colleagues

from academia and industry. Irvin Stewart, Executive Secretary in Conant's National Defense Research Committee (NDRC), managed the Committee on Publication of Scientific Information, whose seven members included Williams College president and OSRD historian James P. Baxter 3d,[14] Karl Compton, James Conant, and Merle A. Tuve, Chief Physicist of the Department of Terrestrial Magnetism (DTM) of the Carnegie Institution of Washington.

During the war, Tuve led the NDRC's development of the proximity fuse, while directing JHU's Applied Physics Laboratory, and also served on 1944's Special Committee on Post-War Research. Charles Edward ("Electric Charlie") Wilson chaired that civilian-military group, appointed by Secretary of War Stimson and Secretary of the Navy Forrestal, whose members included Karl Compton, Frank Jewett, and Jerome C. Hunsacker, the innovative aeronautical engineer and Navy Captain who briefly led the new Naval Research Board in 1941 before replacing Bush later that year as the Chairman of the National Advisory Committee for Aeronautics (NACA). Wilson's Special Committee recommended founding a civilian-military, scientific Research Board for National Security, as a temporary special agency of the National Academy of Sciences (NAS), in succession to but in the style of the for-the-duration-only OSRD. The new Board, established early in 1945, comprised 20 civilians and 20 officers of general and flag rank, including the executive committee led by Karl Compton. Other members of the Board included Rear Admiral Harold Bowen, Chief of the Office of Research and Inventions since May 1945; University of Rochester physicist Lee A. DuBridge, who directed MIT's Rad Lab during 1940–45 and now presided at Caltech; Jerome Hunsaker; Ernest Lawrence; Ben Moreell, now a Vice Admiral; Linus Pauling; and Isidor Rabi.

The OSRD's four committees consulted a number of other specialists and reported their considerations and recommendations to Vannevar Bush between January 9 and June 4, 1945. Bush wrote a 34-page summary to accompany the committees' reports that formed appendixes 2 through 5 in the draft volume. J. Merton England, in his "A Patron for Pure Science," noted Bush's brief meeting with Truman on June 14.[15] The President read and approved the draft, agreed to release it, and promised to petition Congress after gaging public opinion. Bush emphasized that

> **[e]arly action on these recommendations is imperative if this nation is to meet the challenge of science in the crucial years ahead. On the wisdom with which we bring science to bear on the war against disease, in the creation of new industries, and in the strengthening of our Armed Forces depends in large measure our own future as a nation.[16]**

Bush transmitted the report to Truman with a letter dated July 5, but he did not wait for the President's return from Potsdam. By the time "Science—The Endless Frontier,"[17] delayed by higher priority appropriations documents at the Government Printing Office (GPO), appeared on July 19, Bush arranged for legislative action. On that day, Senator Warren G. Magnuson (D–WA) and Representative Wilbur D. Mills (D–AR) introduced bills inspired by Bush and his committees' recommendations. Establishing a national research foundation might end the Research Board for National Security that Senator Harry F. Byrd (Sr., D–VA) especially wished to continue.

The diversity of opinions about what sort of science should be advanced by the Federal Government renewed the old debate about "basic" versus "applied" studies. In 1945, some of the scientists who wished to make up their claimed wartime shortfall in scientific capital, revived the terms "fundamental" and "background" research as more effective sales tags than basic or "pure" science. The urgency of the Nation's domestic and foreign concerns led many of the other disputants to stress applied research. In responding to Roosevelt's queries of 1944, Vannevar Bush favored blending support for both types of science but not in the

type of agency recommended by Senator Harley Kilgore. Bush urged the Federal Government to "accept new responsibilities for promoting the creation of new scientific knowledge and the development of scientific talent in our youth."[18] These responsibilities not only affected health, jobs, and national security but provided a modern way for the Government to foster opening new frontiers, as required by a long-standing U.S. policy. Effectively discharging such responsibilities would require the full attention of an agency devoted to that purpose. No Congress-funded agency in the existing governmental structure seemed able to supplement the support of fundamental research in academia and research institutes, support research on new weapons for the armed services, or administer a program of science scholarships and fellowships.

Vannevar Bush recommended establishing a Federal foundation to administer funds authorized "to support scientific research and advanced scientific education"[19] that would meet five fundamental requirements: (1) funding stability to ensure long-range programs; (2) citizen administrators selected for their capacity, interest, and understanding; (3) funds distributed by contracts or grants based on excellence and given only to nonfederal organizations; (4) colleges and universities given control of the "policy, personnel, and the method and scope" of the funded research (a condition "of the utmost importance"[20] to Bush); and (5) the agency made responsible to Congress and the President, especially for budgets, funds allocation, reports, and audits. Specifically, Bush recommended a national research foundation composed of a controlling board of nine members of broad interests and experience, who understood the peculiarities of scientific research and scientific education but were not otherwise connected with the Federal Government. Bush's table of organization included a director, appointed by and responsible to the members, and staff offices for counsel, finance, planning, and personnel. Each of the five program divisions—medical research, natural sciences, national defense, scientific personnel and education, and publications and scientific collaboration—would have a chair and at least four other persons, appointed by the members, and an executive officer selected by the director. The new foundation, Bush recommended, should have stable funding for at least 5-year intervals. He suggested $33.5 million for the initial year of full regular operation and $122.5 million in the fifth year, by which time "operations would have reached a fairly stable level."[21]

Isaiah Bowman's Committee members, in their report, appendix 3 of "Science—The Endless Frontier," described fundamental studies as "research without specific practical ends" that resulted "in general knowledge and understanding of nature and its laws." This knowledge in turn provided "the means of answering a large number of important practical problems, though it may not give a specific solution to any one of them."[22] Background research, the members continued, included such scientific endeavors as the "preparation of accurate topographic maps and geologic maps, the collection of meteorological data, the determination of physical and chemical constants, the descriptions of species of animals, plants, and minerals, and the establishment of standards for hormones, drugs, and X-ray therapy," which provided "essential data for advances in both pure and applied science." Successful studies required establishing as "reasonably clear" the objectives of background research before undertaking investigations. "Thus, comprehensive programs may be mapped out and the work carried on by relatively large numbers of trained personnel as a coordinated effort."[23] By their definition, applied research differed from fundamental science by the fact that "the objective can often be definitely mapped out beforehand, [and] the work lends itself to organized effort." "If successful," the Committee emphasized, "the results of applied research are of a definitely practical or commercial value."[24]

British biologist Julian S. Huxley concluded in his "Science and Social Needs" "that the simple alternative of pure versus applied [science] is quite inadequate." He wanted "at least four categories." "At one end," Huxley thought, was

"'fundamental' research, with no practical objective conspicuously in view—like atomic physics or experimental embryology." Then came "background research, which must be quite fundamental, but has some distant practical objective—as in the case with soil science, or meteorology, or animal breeding." At the other terminus, "you have 'applied' research, with an immediate objective, like research on discharge tubes for lighting purposes, or on mosquitoes, for getting rid of malaria."[25]

The major conclusion in the second of two reports by Senator Kilgore's Subcommittee on War Mobilization, of the Committee on Military Affairs, also issued in July 1945, "closely paralleled"[26] that of Bush's committees. Kilgore and his supporters continued to press for specific differences in agency organization and policy, including a director appointed by the President, rather than Bush's part-time board of advisers, no patents for the results of federally supported research, a geographic distribution of funds, inclusion of the social sciences, and military participation. Kilgore introduced his own legislation to attain these goals on July 23. Senator William Fulbright's own legislation, introduced to establish a bureau of scientific research in the Department of Commerce, predated both the Kilgore and Magnuson bills. Truman endorsed the basic aims in Kilgore's bill during his message to Congress in September.

During October 8–November 2, as England recalled, Kilgore, Magnuson, Fulbright, and other Senators began public hearings for greater perspective "on bills embodying the recommendations for increased peacetime support of science and providing for the creation of a Federal scientific foundation." "More than 100 witnesses from all sections of American life," including Bowman, Bush, Oppenheimer, and other civilian and military specialists, favored the foundation but also noted "the problems involved in its creation."[27] Kilgore, in summarizing the testimony for the American Association for the Advancement of Science (AAAS) on December 5, said that the Nation "must have, and must have *now*, a full-fledged Government agency run by scientists."[28] Before that could happen, he urged, its promoters must agree on a plan to secure the best organization and its management, legislation ensuring free dedication to the public and full publication of research, and identification of those "social and economic problems which scientists can help solve."[29] Kilgore and his subcommittee carefully considered three types of administration for the foundation: (1) one Presidential appointee with sole authority; (2) a board of 3 to 9 full-time members, all appointed by the President and one of whom he would choose as its chairman; and (3) a single Presidential appointee as chief and advised by a board of 5 to 15 representative members from academia, industry, or elsewhere, selected by the President, but serving only part time. Kilgore, favoring the third option, introduced a bill to achieve this "national investment that may yield undreamed-of returns in knowledge, in wealth and in human progress."[30] A letter from Bowman's ad hoc, 35-member Committee Supporting the Bush Report, endorsed by some 5,000 scientists and other interested persons, went to Truman on November 24. Kilgore revised his bill and reintroduced it on December 21.

As President Truman evaluated those congressional proposals for continuing and expanding federally sponsored research and development, he also moved to express his similar concern for the discovery, use, and conservation of natural resources, especially "the long range world-wide need for new sources of petroleum and other minerals"[31] and "the protection and perpetuation of fishery resources."[32] On September 28, 1945, Truman declared the "Natural Resources of the Subsoil and Seabed of the Continental Shelf"[33] and the "Coastal Fisheries in Certain Areas of the High Seas"[34] subject to the jurisdiction of the United States and under its control but without impeding free navigation thereon. "In cases where the continental shelf extends to the shores of another State, or is shared with an adjacent State, the boundary," the President promised, "shall be determined by the United States and the State concerned in accordance with

equitable principles."[35] In protecting America's coastal fisheries, Truman also hoped to improve "the jurisdictional basis for conservation measures and international cooperation."[36] The U.S. Department of Justice filed a suit on May 29, 1945, in the U.S. District Court in Los Angeles to determine whether the Federal Government or the State of California owned the energy and mineral deposits in the tidelands. Truman, in the two Executive orders issued on September 28, 1945, reserved and set aside the Continental Shelf's natural resources[37] and placed them "under the jurisdiction and control of the Secretary of the Interior, for administrative purposes, pending the enactment of legislation,"[38] and provided for the establishment of fishery conservation zones. The U.S. Supreme Court's ruling on June 23, 1947, confirmed full Federal dominion over them.

Congress remained more immediately concerned with the organization of atomic energy investigations and research in the armed services. As soon as the war ended, several Members of Congress introduced bills to control atomic energy. Truman, making good his promises of August 6, sent a special message to the legislators on October 3, in which he discussed the international and domestic aspects of the problem. In both areas, the President asserted, "the release of atomic energy constitutes a new force too revolutionary to consider in the framework of old ideas."[39] In the international realm, Truman conceded, the essential theoretical knowledge used to construct nuclear weapons already was widely known. He espoused the idea of "international arrangements, looking, if possible, to the renunciation of the use and development of the atomic bomb." The President now pledged to initiate talks toward achieving that goal, first with representatives of the British and Canadian Governments, and then with those of other nations but "these discussions will not be concerned with disclosures relating to the manufacturing processes leading to the production of the bomb itself."[40] Continued secrecy in that area, the President believed, would gain for America at least the minimum 15-year monopoly predicted by Major General Leslie Groves, who thought known uranium ores controlled by the Soviet Union too insignificant to successfully support the fabrication of plutonium and (or) uranium bombs. Some British experts, however, forecast only a 5-year monopoly. Truman proposed creating a U.S. atomic energy commission, composed of members he appointed, to control all nuclear stockpiles and plants, acquire minerals from which atomic energy was derived, and conduct all research, experimentation, and operations for the development and use of atomic energy for industrial, medical, military, and scientific purposes. America would not recognize any foreign government imposed by force, but Truman pledged that the Nation's atomic bombs would be held in trust for all mankind.

The international control of atomic energy, involving foreign policy as much as science, remained inextricably linked to the West's relations with the Soviet Union. To discuss these issues, President Truman, Britain's Prime Minister Attlee, and Canada's Prime Minister King met in Washington during November 1945. The three leaders proposed entrusting the international control of atomic energy to a United Nations (U.N.) commission authorized to complete sequential stages of scientific exchange, development of peaceful uses of atomic energy, elimination of nuclear weapons, and international inspection. Until the commission completed the entire process, the United States would retain a monopoly on its existing nuclear weapons, a condition to which the Soviet Union, with its own bomb program now in higher gear under Lavrenti Beria, Igor Kurchatov, and Boris Vannikov, was unlikely to agree. On January 24, 1946, the U.N. General Assembly established the United Nations Atomic Energy Commission (UNAEC) to study the worldwide control and use of nuclear energy.

The seemingly simple proposal for an atomic energy commission plunged Truman's administration into a long battle over the issue of military versus civilian control of atomic energy, one that came to rival the struggles in America during the last third of the 19th century over the issue of military versus civilian domination

of science. The bill introduced in the 79th Congress' Military Affairs Committees by Representative Andrew J. May (D–KY) and Senator Edwin C. Johnson (D–CO) was based on model legislation drafted in the War Department by General Groves and his colleagues, with help from Vannevar Bush and James Conant. The measure provided for a nine-member, part-time commission empowered to select a full-time administrator; the selectee and some commissioners could be members of the armed forces. In October 1945, Groves, Oppenheimer, and Robert Patterson, who succeeded Henry Stimson as Secretary of War on September 27, supported the May-Johnson bill before the House Committee on Military Affairs. The members of the new Federation of Atomic Scientists, including many of the nuclear specialists who worked on the Manhattan Project, objected to the Army's security restrictions on research and attacked the May-Johnson legislation. Also in October, Senator Brien McMahon (D–CT) successfully urged Senator Harry Byrd and his other colleagues to establish a Special Committee on Atomic Energy and then served as its Chairman. McMahon and the committee's counsel, aided by some of the scientists, drafted an alternate bill and introduced it on December 20.

The McMahon committee's bill for developing and controlling atomic energy provided for fostering private research, controlling and disseminating scientific research and development to encourage scientific progress, conducting Federal programs for research and development, and continuing Government control of production and administration. The legislation also proposed policies and an atomic energy commission of five full-time civilian commissioners, appointed by the President and serving at the Chief Executive's pleasure. The commissioners would be assisted by a general manager and advised by two boards—one general and the other military. The bill gave the commission authority to conduct or contract for exploration and to acquire source materials. The measure encouraged research about nuclear processes, theory and production of atomic energy, utilization of fissionable materials, and protecting health during study and production. It also specified control of fissionable and source materials, authorized military applications, and requested biannual reports to a congressional Joint Committee on Atomic Energy but did not fix the level of funding. The McMahon committee held hearings during January–April 1946. Truman, after meeting with legislators and scientists in the White House, openly opposed the May-Johnson bill, and wrote to McMahon on February 1 to support his alternative that ensured civilian control.

Truman's Executive order of March 4, 1946, revoked his order of September 13, 1945, the latter signed to withdraw and reserve the "lands containing radioactive mineral substances,"[41] but continued their segregation subject to the new provisions for reserving "the rights to fissionable materials in lands owned by the United States." The new order opened to development by "lease, permit, or other authorization," under the mineral laws and especially to veterans, the public lands that contained "substantial deposits of fissionable materials" closed to entry during the last 6 months. The new order also continued to reserve for the U.S. Government the rights to "enter upon the land and prospect for, mine, and remove such materials."[42] An Interior Secretarial order of April 19, 1946, delegated to the USGS Director or Assistant Director the authority that Truman's Executive order gave to Interior for determining fissionable-materials deposits on U.S. lands, "other than public lands."[43]

After considerable debate in June and July 1946, Congress passed the McMahon bill and Truman signed it on August 1. The Atomic Energy Act now reserved to the United States "All uranium, thorium, and all other materials determined * * * peculiarly essential to the production of fissionable material, contained, in whatever concentration, in deposits in the public lands."[44] The new law and an Executive order also transferred full control of all records, materials, facilities, production, research, and information from the War Department to the new U.S. Atomic Energy Commission (AEC), which succeeded the Army's Manhattan

Engineer District (MED) on December 31, 1946.[45] Additional responsibilities for the new AEC would include prospecting for new sources of fissionable material at home and (or) buying it abroad, building more bombs and conducting research and development, controlling information, monitoring international arrangements (treaties), and establishing regulations for nuclear health and safety. David E. Lilienthal, a lawyer who led the Tennessee Valley Authority (TVA) during 1941–46, was confirmed as the AEC's Chairman in April 1947. Lilienthal's four co-commissioners included Cornell physicist Robert F. Bacher, who worked at the MIT's Rad Lab and at Los Alamos and helped to assemble the Trinity device. Gordon R. Clapp, the TVA's General Manager, replaced Lilienthal as the agency's Chairman at Knoxville. The Act also established within the AEC four divisions (Engineering, Military Application, Production, and Research), set up General Advisory and Military Liaison Committees, and founded in Congress a Joint Committee on Atomic Energy.

To aid the AEC, Truman appointed on December 12 a General Advisory Committee for "scientific and technical matters relating to materials, production and research, and development."[46] The Committee's nine members included Conant, DuBridge, Fermi, Oppenheimer, Rabi, and Seaborg, again at Berkeley. Truman, as advised by the Committee, appointed Carroll L. Wilson, Bush's executive assistant in the OSRD, as the AEC's General Manager. The MED's military functions and personnel passed to the Armed Forces Special Weapons Project, established by a joint letter of January 29, 1947, from the Secretaries of War and the Navy, and led by Groves, who also served on the AEC's Military Liaison Committee. Truman's Executive order of February 21 extended to the AEC[47] the provisions of an order in 1942 that authorized the emergency purchase of war material abroad. The USBM and the USGS expanded their ongoing programs of exploration for these commodities.

Vannevar Bush and his colleagues' definitions of fundamental and applied research clearly applied to the mineral-resources investigations and other studies done by the USGS from its founding in 1879. The USGS continued to be deeply involved in background studies, but Director Wrather had his own views of how to meet the challenges of postwar science, and they began with an almost complete reordering of his agency's internal structure. Chief Geologist Bradley, aided by Wrather and Assistant Director Nolan, continued reorganizing the Geologic Branch and formally established the new arrangement in the fall of 1945. To confirm the importance of the Interior Department's efforts outside the national domain, Secretary Harold Ickes established a Committee on Foreign Cooperation on August 21. Ickes appointed First Assistant Secretary Michael Straus to chair the Committee, which included Assistant Secretary Oscar Chapman and representatives of the Divisions of Territories and Island Possessions and of Budget and Administrative Management, the U.S. Bureau of Reclamation (USBR), the Fish and Wildlife Service (FWS), the USBM, and the USGS, represented by Harold Bannerman, Chief of the Geologic Branch's Division of Economic Geology. Ickes founded the new Committee to coordinate Interior's foreign programs and "to stimulate the development of" and secure funding for "sound cooperative programs"[48] to be proposed to the State Department's Interdepartmental Committee on Cultural and Scientific Cooperation, on which Straus represented Interior until replaced by Nolan on April 1, 1946.

Bradley's reorganization of the Geologic Branch's program units reflected both Ickes' continuing concerns and the Branch's own work during the war.[49] The Chief Geologist continued 1944's Committee for Cooperative Investigations Abroad, established a new Section of Geophysics, and reorganized the Trace Elements Unit (TEU). Bradley renamed the reactivated geologic-map editing unit as the Geologic Information and Reports Section, responsible for improving and expediting responses to public inquiries and more promptly and efficiently

processing texts and maps. On October 2, 1945, he redivided the Section of Areal Geology and Nonmetalliferous Deposits. Bradley also established a special advisory research staff for long-range planning and founded a technical services and administrative group. He also changed leaders in two regional offices: in Spokane, Albert E. Weissenborn took charge of work in Idaho, Montana, Oregon, and Washington, and in Salt Lake City, Charles Hunt assumed responsibility for efforts in Arizona and Utah. Bradley confirmed Robert A. Laurence as Regional Geologist at Jefferson City (later at Knoxville) in Tennessee. He closed the Branch's regional offices at College Park and Rolla after they completed their wartime responsibilities.

Bradley also reorganized the Geologic Branch's two Divisions: Economic Geology and Basic Sciences. Bradley, Nolan, and Wrather "agreed that a program of research should be incorporated with the economic geology demanded by the public,"[50] continuing a policy begun in 1879 by Director King. Bannerman's Division received the TEU; its supervisor Frank W. Stead previously aided the Branch's efforts to develop new geophysical techniques, especially those for detecting radioactivity. Bannerman also retained John Dorr 2d's Committee for Cooperative Investigations Abroad and three Sections—Hugh Miser's Geology of Fuels, Charles Park, Jr.'s Geology of Metalliferous Deposits, and Josiah Bridge's Geology of Nonmetalliferous Deposits.

Seven other Sections and one Unit went into the Division of Basic Sciences, now led by Harry Ladd as William Rubey's replacement. The NAS elected Rubey a member in April 1945; he still chaired the National Research Council's (NRC's) Division of Geology and Geography, but he had just been named as well to a three-man committee to survey the NRC's functions and future activities. Rubey joined Foster Hewett, Gerald Loughlin, and Aaron C. Waters on the Geologic Branch's long-range planning staff. Ladd's Sections included Engineering Geology, founded under Edwin B. Eckel in November 1944 and returned to him when he came back from Europe; John B. Reeside, Jr.'s Paleontology and Stratigraphy; Clarence Ross' Petrology; Waldemar Schaller's Chemistry and Physics; John Hack's Areal Geology; James Balsley's Geophysics; and Don L. Carroll's Geologic Information and Reports. Ladd also supervised the Military Geology Unit, now under Assistant Chief Esper Larsen 3d after Charles Hunt's transfer to Salt Lake City.

Bradley, mirroring Wrather's wishes for newer and younger managers of the USGS principal program units, chose them to lead four of the Division's subgroups. James Balsley, John Dorr 2d, John Hack, and Esper Larsen 3d, had been with the agency for seven or fewer years. Dorr, then 35, was the oldest of the quartet. Larsen, nearly 33, was a year older than Hack. Balsley, at 29, was the group's youngest member. Bradley's youth movement, no less than his other organizational changes, was noticed by the USGS Pick and Hammer Club but went unremarked on stage until 1947 in the Club's second postwar show—"Slow Boat, or Nothing But the Truth"—their version of *Show Boat*, the 1927 musical by Jerome Kern and Oscar Hammerstein 2d. The sing-along "Wonderments," the long-used audience warmup, recalled:

> **A time when Section Chiefs were marked by graying hair,**
> **Acquired through many seasons doing Survey work with care,**
> **Now Section Chiefs are younger and their science is veneer—**
> **They multiply like locusts in their gala seventh year;**
> **What used to be the top is now the start of their career.**[51]

In "Gullible's Travails," the 1946 satire, the four-verse "Jolly Chiefs," a reworded "When I Was a Lad" from Gilbert and Sullivan's "H.M.S. Pinafore," began the internal critique of the other results of Bradley's reorganization. His enthusiastic and extensive participation in past shows did not restrict additional pointed comments in 1947 about other changes by "Wilnot Medley, Grand Duke of d'Visions"[52] and the other "chiefs" on his staff, including the new

"schedograph," or "Sched-u-graph." Bradley and his administrators, in using this new aid to monitor the work and travel of Branch personnel, no matter where they labored or stayed, seemed to have increased their own work by half. In "A Round Delay," sung to "The Wearing of the Green," they summarized the changes by bemoaning how:

> **Some streams in spate flow swift and straight, with nary a bend or crook,**
> **And that's the kind Bill had in mind, when first he undertook**
> **Streamlining of geology, but look what happened then!**
> **Regimentation has produced a different regimen!**
>
> **Our stream meanders slowly through the jungles of red tape,**
> **And splendid plans in eddies writhe and ne'er take final shape;**
> **Bill Bradley in his iv'ry tower, high above the ground,**
> **May think we're going places, but we're whirling round and round![53]**

Bradley also "agreed in principle" with Wrather and Nolan that certain gifted members of the Geologic Branch and other branches "could be of greater service to the science and the bureau when working on research projects in which they were personally interested, and for which they were temperamentally and professionally qualified." They planned to free such people "as far as possible of administrative duties" and intended that the selectees "should command a salary rating based on their individual worth."[54] The three leaders knew that in past years the U.S. Civil Service Commission (CSC) only "had been inclined to approve higher ratings to scientists who performed administrative duties, even though their scientific qualifications were no higher than others who came under their supervision."[55] Bradley, hoping to avoid difficulties in favoring the research of a few colleagues over the work of his other scientists, cautiously began seeking ways and means to promote the establishment and funding of a few of these "supergrade" slots. His efforts were supported on August 1, 1947, when the 80th Congress and the President authorized in Public Law 313 up to 30 positions in the War Department and 15 others in the Navy Department to promote research and development that required "the services of specially qualified scientific or professional personnel."[56] That statute placed the new positions within the classified civil service, required CSC approval of candidates' qualifications but not competitive examinations, and authorized yearly salaries of $10,000 to $15,000.

On November 1, 1945, Nolan began representing the Interior Department on the Civil Service Commission's seven-member Advisory Committee on Scientific Personnel (ACSP), chaired by physicist and OSRD veteran Merriam H. Trytten, of the NRC's Office of Scientific Personnel. The ACSP facilitated in-service, graduate-level training in the Washington metropolitan area and also reviewed the regulations for the science positions in the civil service. Its two auxiliary committees prepared recommendations for review by the ACSP and the CSC; USGS geologist Kenneth Lohman served as one of the seven members of a group that evaluated regulations; later, he advised the Committee on Classification of Scientific Personnel. Initial delegations of personnel authority to the USGS began on December 17, when, with the transfer to the agency of its official files, the USGS began keeping and managing its own records. On February 4, 1946, Truman issued an Executive order that directed the CSC to resume peacetime operations and also contained provisions based on the ACSP's initial recommendations.[57]

As Truman addressed these and other inherited and new issues during fiscal year 1945–46, Bradley's earth scientists remained fully engaged in the war effort while the conflict lasted and then prepared reports on the wartime projects. Thereafter, as the Geologic Branch's reorganization continued, they began returning, at least part time, to their regular long-range research. That effort presented some new challenges and opportunities. Branch personnel used new or improved

This aerial view of the eastern front of the San Rafael Swell looks north across part of the Green River Desert and the San Rafael River in the foreground. The stratigraphic units delineated in 1946 by nonstandard symbols added to the photograph include (from oldest to youngest) Coconino Sandstone and Kaibab Limestone (Kc, "Permian"); Moenkopi Formation (M), Shinarump Conglomerate (S), and Chinle Formation (C) (all "Triassic"); Wingate Sandstone (W) and Navajo Sandstone (N) (both "Jurassic?"); Carmel Formation (Ca) and Summerville Formation (Su) (both "Jurassic"); and Salt Wash Sandstone Member (SW) and unnamed "shale" member (Mo) of the Morrison Formation (both "Cretaceous?" but now assigned to the Upper Jurassic). Geologist Arthur Baker, as part of USGS regional studies in southeastern Utah, mapped strata in the Green River Desert-Cataract Canyon area in 1930–31, providing regional-framework information used in the subsequent exploration for uranium on the Colorado Plateau. (Photograph by Barnum Brown, American Museum of Natural History; published in Baker, 1946, pl. 16. Photograph reproduced from the folded illustration in the published report; the vertical lines are creases in the paper print.)

methods of chemical and physical analyses, including radioactivity measurements, spectrographic procedures, and X-ray techniques. Petrologic studies included aluminum- and zinc-bearing clays and related substances. Significant applied work also began or continued on lead, zinc, and other war-depleted base metals, phosphates, coals, oil, and oil shales. Stratigraphic-framework and construction-materials investigations concentrated on the Missouri River Basin and the Rocky Mountains. Branch members also investigated landslides, made airborne-magnetometer surveys, and studied mineral resources abroad, including those in Bolivia, Brazil, Chile, Cuba, Mexico, and Panama, in cooperation with the State Department and the Foreign Economic Administration. At the end of fiscal 1945–46, the Branch employed nearly 450 persons full time and 35 others part time, a net loss of nearly 240 people since the end of fiscal 1943–44.

Wrather's plans for reorganizing the Topographic Branch, the agency's second-oldest program unit, were well underway within a month after the war ended, and they continued as USGS topographers completed maps and charts for the War Department during the remainder of fiscal year 1945–46. Wrather knew that Thomas Pendleton, Chief Topographic Engineer (CTE) since March 1943, "was a very competent engineer and had contributed substantially toward shifting the work * * * to the newer techniques of photogrammetry" in and after World War I. The Director also believed that Pendleton's "frail physique," "sensitive temperament,"

and tendency to worry "were undermining his health." Wrather encouraged Pendleton, now nearing 60, to "devote himself to research in mapping,"[58] but Pendleton refused to end his tour as the CTE, and Wrather did not insist on the change. To help reorganize the Topographic Branch, the Director chose Colonel Gerald FitzGerald, who led the Aeronautical Chart Service since 1943 in the trimetrogon-photogrammetric compilation of maps that covered more than 15 million square miles worldwide. FitzGerald, wishing to return officially to the agency and continue his prewar service, "was anxious to get George D. Whitmore, chief of the mapping service of the TVA, in the Survey."[59] Wrather successfully convinced Ned H. Sayford, who had led TVA's Maps and Surveys Division at Chattanooga since 1934, that "we might offer" Sayford's Assistant Chief Whitmore "a wider field of opportunity, which might attract him."[60] Whitmore reported for duty with the USGS on September 17, 1945, but the U.S. Army Air Forces (USAAF), reluctant to release FitzGerald from active duty, did not comply until November 1 and then only after a personal request from Secretary Ickes.

USGS topographers faced a daunting task as they returned to peacetime operations with their emphases on domestic mapping. Of the 48 percent of the country mapped to date, only one-quarter of that coverage remained adequate for current use, and many of these maps required revision before they could again be used as meaningful bases. Wrather and FitzGerald quickly agreed that the Topographic Branch "should be completely overhauled and reoriented" to eliminate plane-table surveying as much as possible, except for ground checks, and to adopt the newer and war-proven photogrammetric methods in "a long-neglected civilian program" of large-scale mapping, preferably at 1:24,000. They also decided to continue the decentralization of field operations and to begin a program to revise existing useful maps. Wrather got Ickes and the CSC to approve full-time positions for FitzGerald and Whitmore as Staff Topographic Engineers, respectively, for Plans and Coordination and for Research and Technical Control. They would "advise and assist"[61] the Chief Topographic Engineer and the Director in planning and implementing both the present programs and the anticipated long-range effort to ensure responses to national needs and to use efficient and economical mapping systems. Wrather made FitzGerald's staff unit responsible for map information, estimates and plans, production control, and liaison and coordination with State and other Federal officials. To Whitmore's staff unit went authority for research and development of procedures, techniques, and equipment.

Gerald FitzGerald and George Whitmore became chiefs of their respective and formalized Divisions on August 27, 1945. Wrather, whenever possible, joined FitzGerald and Whitmore in studying the Topographic Branch's requirements and planning how to meet them by perfecting "a pattern which could be expanded to meet future needs without material changes." The two new chiefs placed in responsible positions younger men "who could be expected to respond favorably to the new viewpoint in mapping."[62] Russell K. Bean, one of these younger men, promoted improved photogrammetry in topographic mapping. In the summer of 1945, Bean led a team that cooperated with the Army Engineers in locating, confiscating, and shipping to the United States some of the Zeiss stereoplanigraphs and other photogrammetric equipment remaining in Germany. Fitzgerald and his staff began to prepare a comprehensive mapping plan to overcome deficiencies in map information within 15 years.

While Wrather and his advisers continued their efforts to remake the USGS program branches during the winter of 1945–46, President Truman delivered his initial State of the Union and Budget messages (combined) to Congress, and Secretary Ickes resigned. On January 21, 1946, Truman called again for "building a just and enduring peace."[63] As the "strength of our Nation and the welfare of the people rest upon the natural resources of the country," he reemphasized, they required

Julius Albert Krug (1907–70), the 33d Secretary of the Interior (1946–49), served as the Tennessee Valley Authority's Chief Power Engineer in 1938–40 before shifting to the War Production Board, which he led during 1944–45. He succeeded Harold Ickes as Interior Secretary on March 18, 1946, and served until December 1, 1949. During 1949, Krug also received an honorary doctorate of engineering from the Colorado School of Mines. After leaving Interior, Krug became a power consultant in Washington and cofounded the Volunteer Asphalt Company in Knoxville, Tennessee. (U.S. Office of War Information photograph D–6274–A, from the Library of Congress, Prints and Photographs Division, 3c25763.)

taking, "as soon as possible, an inventory of the lands, the minerals, and the forests of the Nation."[64] Truman again asked the legislators to consider his "proposed central Federal research agency."[65] In January, the President also announced Edwin W. Pauley as his nominee to serve as Under Secretary of the Navy. During 1940–45, Pauley helped Roosevelt to fill Churchill's request for tankers, aided plans for establishing a Petroleum Coordinator for National Defense, coordinated Lend-Lease oil supplies for Britain and the Soviet Union, and chaired the Democratic National Committee. In May 1945, Truman appointed Pauley the senior U.S. representative on the Allied Reparations Commission. Pauley, in his ambassadorial capacity, attended the meetings at Moscow and Potsdam before traveling that fall to China, Korea, and Japan as U.S. Reparations Commissioner for Japan. Republican members of the Senate's Naval Affairs Committee felt that Pauley, the California oil producer, real-estate developer, and Democratic committeeman for his State, would have a conflicting interest in the Nation's Naval Petroleum Reserves. They summoned Ickes as a witness in the confirmation hearings, although Truman opposed his participation. Ickes, in his second appearance before the committee on February 5, disclosed his diary's entries that described Pauley's efforts to tie a contribution from oilmen to an abandonment of the Federal suit on tidelands oil. Truman continued to support Pauley, perhaps seeing him as Forrestal's eventual successor.

On February 13, 1946, Ickes resigned in protest, as he did so often during his years with Roosevelt, expecting to get his way in the Pauley matter or at least receive an FDR-style reaffirmation of Ickes' irreplaceability at Interior. Instead, Truman quickly accepted Ickes' decision to depart. When Ickes asked for 2 weeks to finish his responsibilities, Truman gave him 2 days to clear out his desk. Wrather later recalled that "[o]n the whole, I was sorry to see him go."[66] In 1947, The Pick and Hammer Club's players portrayed some of the effects of Ickes' departure on the USGS in "Well, Wrath-er," to the tune of "Oh, Willow, Titwillow, Titwillow!" from Gilbert and Sullivan's "Mikado":

Now our Harold has left us, but I stay behind—
I Wrather; Yes, Wrather; Bill Wrather,
And I struggle with letters that have to be signed.
By Wrather; just Wrather, Bill Wrather.
The Comptroller and Budget are causing me tears,
And the regional set-up that threatens gives fears,
While the callers I sidetrack to Nolan and Sears
Yell "Wrather! O, Wrather! Bill Wrather!"[67]

To succeed Ickes on February 26, 1946, Truman chose Julius Krug, the former chairman of the War Production Board. The Senators confirmed Krug on March 5, and the new Interior Secretary took his oath of office on March 18. Krug had "a calm, deliberate air" and impressed Wrather "from the start by his rational, open-minded attitude toward the affairs of the Department."[68] The Senators rejected Pauley, who, with Truman's consent, withdrew his nomination on March 13 and returned to his reparations work in China, Japan, and Korea.

The House Subcommittee on Appropriations for the Department of the Interior (DoI), still chaired by Jed Johnson, began its hearings on Interior's requested budget of about $342,119,000 for fiscal year 1946–47 on February 4, 1946. For the USGS, the Bureau of the Budget (BoB) recommended a direct appropriation of $13,131,000, almost twice the $7,314,000 approved on July 3, 1945. An additional $2 million, to support USGS mapping and studies of construction materials, power sites, and floods, was part of the USBR's nearly $23.8 million request for developing the Missouri River Basin. Direct appropriations recommended for USGS topographic surveys totaled $5 million, the amount suggested by the Secretaries of War, Interior, and Commerce in their joint report in 1939. The increase of $2.8 million over the previous year's funding included $500,000 for the purchase of

surveying and mapping instruments, $345,000 for trucks for field-survey parties, and $237,000 for cooperative surveys. About $2,436,000, more than double the last year's appropriation, would go to geologic surveys, but the USGS did not request separate monies for strategic-minerals investigations. Increased funding would support the start of a long-range plan to complete the geologic mapping of the country in no more than 30 years, which would require successively larger appropriations each year until they reached $5 million in fiscal 1949–50. The $3 million for water-resources investigations represented an increase of $883,000, a portion of which included a transfer of base so that funds previously shifted from other Federal agencies for these studies would be appropriated directly to the USGS. The agency asked for nearly $136,000 for the classification of public lands, more than $214,000 for the supervision of mineral leasing, and about $223,000 for the publication of maps and reports.

Assistant Secretary Oscar Chapman, in testifying before the House subcommittee, repeated much that Ickes said the year before. Chapman, soon to be Krug's Under Secretary, pointed out that requirements during the war years forced the United States to draw upon its natural resources at an unprecedented rate. "Ironically, in seeking to preserve the American way of life," Chapman continued, "we destroyed or seriously damaged much of the very thing which, in a material sense, made that way of life possible." Reserves of metals, petroleum, the higher grade coals, and some nonmetallic ores, which Americans once thought made them "more than self-sufficient for many generations to come," had been more depleted than generally realized. If future standards of living were not to be lowered "painfully,"[69] Chapman cautioned, the U.S. Government must take the lead in restoring and promoting the conservation as well as the development of the Nation's natural resources, and it must also foster and support scientific and technological studies in the search for new sources and uses of materials and power.

When Director Wrather and his program and budget managers appeared before the House's Interior subcommittee on February 12, the legislators professed amazement that the agency did not expect to revert to its prewar budget. In response, Wrather defended the expanded request by saying it did reflect efforts by the USGS to return to its peacetime activities but the adjustment to wartime demands required complete disregard of normal activities so that the agency now was years in arrears in much of its work. He asserted that

> **[t]he hearings on the Kilgore and Magnuson bills and the Bush committee report all called attention to the fact that during the war we applied science and technology brilliantly and with great success, but that no advances were made in basic theory; and that our technologic leadership in the future would require renewed attention to fundamental research. This situation is as true of the fields of geology, hydrology, and photogrammetry as it is of the fields of chemistry and physics that are so much better known.[70]**

Crediting past Directors, like King, Walcott, and Mendenhall, Wrather recalled that

> **[s]uch research work has in the past been an essential part of the Survey's program and it must be resumed without delay if the Survey is effectively to carry forward its investigation of our natural resources. * * * the experience of the war years has taught us that the functions of the Geological Survey require a scale of operations which we have never remotely approached in the past.[71]**

USGS operations in the past, Wrather added, had been on so limited a scale that the agency had "only pecked at the problem and dealt with it piecemeal." A "far greater effort," he urged, would now have to be made in order for the USGS "to properly occupy the field which we are supposed to fill in the set-up of Federal

agencies."[72] Wrather warned the legislators that although the budget allowance for topographic surveys had been nearly doubled for the coming year, it would have to be more than doubled again if they wished the national program to be completed within the coming generation. The Nation's known mineral reserves had been depleted to meet war demands, but the degree of depletion had not been adequately established. Known reserves were "uncomfortably low in many categories" and "dangerously low in others." The USGS remained responsible for assembling and evaluating this information nationwide as well as for exploring for new sources of supply. Properly evaluating the Nation's water resources, Wrather continued, involved a "limitless task" ahead. As for work by the Conservation Branch, he added, "This activity yields substantial revenue to the Federal Government and the States. It deserves to be handled in the most businesslike manner possible."[73]

Wrather's plea did not impress the members of Jed Johnson's subcommittee. They approved for topographic surveys $2,626,100, an increase of less than $466,000 over the amount provided for fiscal year 1945–46 and only a little more than half the sum requested. As only $759,000 had been granted directly for such surveys in fiscal 1940–41, the Representatives remained at a loss to understand why the new appropriation should be increased sevenfold. They endorsed for geologic surveys only $1.2 million, a little less than half the amount requested and less than the combined appropriations for geologic surveys and strategic-minerals studies in 1945–46. The subcommittee reduced funding for water-resources investigations to the 1945–46 level and required the USGS not to use any of this money for drilling water wells for the purpose of supplying water for domestic use. The members also decreased the appropriations for classifying lands, supervising mineral leasing, and publishing and the funds to be received from the USBR to support USGS work in the Missouri River Basin.

As the House subcommittee considered the USGS request for funding during fiscal year 1946–47, U.S. problems in foreign relations and domestic issues grew in intensity. On February 9, 1946, Premier Stalin, as head of state, remarked publicly that he foresaw no possibility of establishing a peaceful world order because capitalism, monopoly, and imperialism commanded the globe outside the Soviet Union. Four days later, a Communist-dominated Government led by former partisan Kim Il Sung took over the northern half of Korea, the more industrialized portion of the peninsula compared to the dominantly agricultural south. On February 15, Canada revealed Soviet attempts at atomic espionage within the Dominion and arrested 22 persons. Six days later the U.S. Joint Chiefs of Staff (JCS) warned President Truman that the Soviet Union now was America's greatest threat abroad. On February 22, George F. Kennan, the U.S. chargé d'affaires in Moscow, warned the State Department in a long telegram that the Soviet Union was "a political force committed fanatically to the belief that with [the] U[.]S[.] there can be no permanent modus vivendi, that it is desirable and necessary that the internal harmony of our society be disrupted, our traditional way of life be destroyed, [and] the international authority of our state be broken, if Soviet power is to be secure."[74] Eastern Europe likely would have to be conceded to the Soviets, Kennan continued, but they should be deterred from further advances and contained by American power and a system of alliances.

Senator Arthur Vandenberg, reporting on the U.N. General Assembly's meeting in London, told his colleagues on February 28, 1946, that U.S. foreign policy must match the Soviet Union's in outspokenness and firmness. On the following day, Secretary of State James Byrnes assured the Overseas Press Club that the Truman administration would not ignore threats or uses of force made by any country contrary to the principles and purposes of the U.N.'s Charter. One day later, Truman ordered the Navy to send the battleship *Missouri* to return home the body of the late Turkish Ambassador to the United States, and the President pledged

support to Iran when the Soviets refused to remove their troops there. Showing the flag at Istanbul helped to end Soviet demands for bases in Turkey. *Missouri* and her escorts visited Piraeus on the return voyage. In August, *Franklin D. Roosevelt*, one of the three new and larger *Midway*-class aircraft carriers, and her escorts also sailed to Piraeus to support the pro-Western forces in the renewed civil war in Greece. In September, a plebiscite led to the return of King George II to Athens. The Navy also sent a light cruiser to the "free city" of Trieste, whose ownership Italy and Yugoslavia still disputed, and in October, reestablished a permanent naval presence, the future 6th Fleet, in the Mediterranean.

Seven months earlier, former Prime Minister Churchill made the situation in Europe dramatically clear. On March 5, 1946, Churchill spoke after receiving an honorary degree from Westminster College in Fulton, Missouri. Churchill, with Truman in the audience, decried the "iron curtain" that now divided Europe from the Adriatic near Trieste to the Baltic near Stettin (Szczecin).[75] The people behind the new barrier, Churchill asserted, were all subject, in one form or another, not only to Soviet influence but to a very high or increasing measure of control from Moscow. Churchill called for restoring the Allies' wartime cooperation but not for sharing with the U.N. or any other countries information about the atomic bomb. In China, the agreement between Chiang and Mao threatened to break down. Stalin, like Roosevelt, supported Chiang throughout World War II; Mao favored Kim's Communist revolutionaries in Korea as well as Hõ's Viet Minh. In the hope of ending the full-scale civil war between the Nationalists and the Communists that resumed in Manchuria, Truman sent George Marshall to China in December 1945. Although General Marshall's special mission established another truce during January–April 1946, Chiang and Marshall did not succeed in reaching a lasting settlement with Mao. Fighting resumed after the Nationalists ignored the Communists' demand for joint control of Manchuria, and their conflict continued uninterrupted by the U.S.-Nationalist treaty of friendship, commerce, and navigation signed in November. Chiang, reelected president in a questionable vote in October, supported a new constitution in December to reduce abuses while the Communists continued their forceful program of land reform.

At home, the United States faced another wave of domestic-labor unrest. By mid-March, the strikers decreased in number from a high of some 2 million to about 200,000, but, beginning on April 1, 400,000 members of the United Mine Workers walked out. In May, railroad trainmen and locomotive engineers joined the miners on strike. As prices continued to rise, the unions demanded further increases in salaries.

Carl Hayden's Senate subcommittee on Interior's appropriations began its hearings on the USGS budget for fiscal year 1946–47 on May 17. New member Guy Cordon (R–OR) replaced Harold Burton, who left to become an Associate Justice of the U.S. Supreme Court. Cordon made public-land and resource issues his specialty and also chaired the Republican Policy Committee. Wrather protested the House's cuts in funds for topographic mapping when the agency was "about 4 years behind on our domestic program."[76] He reminded the Senators that "[w]e have never had an opportunity to prosecute mapping on a scale commensurate with national needs. We have merely picked at the job. The appropriations have usually been adequate to meet only the highest priority work. It is possible to anticipate map needs by consultation with the interested agencies, State and Federal, and a priority system can be worked out to complete the maps most immediately needed for such developments as the Columbia River or the Missouri Basin. Yet," he continued,

> **we are obliged to wait until the job is around our neck and then turn heaven and earth to meet the demand in time. Map making takes time, particularly map making with the very rigid specifications of the Survey.[77]**

"As a result of past laxness," Wrather recalled, "we found ourselves at the beginning of war in what might have been a disastrous situation if the threat of invasion had materialized."[78] The Topographic Branch employed as many as 650 people per year during the war, including those paid with transferred funds, and now required $5 million to support the needed permanent staff of 1,000.

The Senate subcommittee, always more sympathetic to the Nation's need for topographic mapping than the House subcommittee, responded to Wrather's plea by recommending the full amount requested by the USGS for fiscal year 1946–47, but its members discussed only briefly the other items in the agency's budget. For geologic surveys, the committee urged the full sum requested, but it approved for water-resources investigations only $2,888,000, or $112,000 less than asked for. The subcommittee did recommend large increases for classifying lands and leasing minerals, and another $662,000 in response to a supplemental request by the USGS to provide for rehabilitating its printing presses. The Senate agreed with its subcommittee's decisions, but, in the final bill for USGS appropriations, the two houses more or less split their differences on funding for water-resources investigations, land classification, and mineral-leasing supervision. They allowed only $3 million for topographic surveys, of which $400,000 was available only for cooperative work with the States and municipalities and $2 million for geologic surveys. As enacted on July 1, 1946, the bill provided nearly $2,499,000 (including a transfer of base) for water-resources studies, of which $1,620,000 could be used only for cooperative work. The total direct appropriation of almost $9,709,000[79] for the USGS for salaries and expenses during fiscal 1946–47 amounted to nearly 74 percent of the requested sum. Supplemental appropriations, funds transferred from outside sources, and miscellaneous repay amounts enabled the agency to draw on about $18,633,000 during 1946–47. Principal transfers included the War Department's $3,349,000; some $2,706,000 from States, counties, and municipalities; the Bureau of Reclamation's nearly $1,989,000; about $242,000 from the State Department; and more than $224,000 from the Navy Department.

As Congress debated the appropriations bills in mid-June 1946, Bernard Baruch, as the United States' chief representative to the United Nations, presented the U.S. proposal for an International Atomic Development Authority. Robert Oppenheimer served as Baruch's scientific adviser, but the ambassador relied on General Groves' opinions. The U.S. plan outlawed the manufacture of nuclear weapons, required the dismantling of existing atomic bombs, and recommended sharing scientific and technological knowledge about them. The proposed Authority would ensure the full exploitation of the peaceful uses of atomic energy and provide countries with security against surprise attack by violators of the weapons ban. The plan would be effected in stages, so that the new agency's control mechanisms operated fully to demonstrate their effectiveness before the United States disposed of its existing nuclear weapons, accepted a prohibition on the manufacture or use of new weapons, and turned over to the Authority all U.S. scientific and technological knowledge of atomic energy.

Truman had an alternate plan. In January, Secretary of State Byrnes appointed a committee, including Under Secretary Dean Acheson as Chairman, Vannevar Bush, James Conant, General Groves, and former Assistant Secretary of War John J. McCloy, to recommend to the President what U.S. policy should be in regard to the proposed international control of atomic energy.[80] Acheson convinced TVA Chairman David Lilienthal to lead a Panel of Consultants that included Oppenheimer and three executives from industry. They recommended an international authority having control of the investigation and use of uranium and thorium, conducting experimental studies of atomic explosives, and developing atomic energy for electric power and other industrial uses.[81] Radioactive materials could be used as biological tracers or in small nuclear reactors that produced only low power

levels; denaturing uranium and thorium would render them unusable for the known methods of making effective nuclear weapons. The Acheson-Lilienthal report,[82] released by Secretary Byrnes on March 29, suggested making the U.N. agency subject to vetoes by Security Council members. Five days after Baruch introduced his scheme, the Soviet Union, whose nuclear-weapon program struggled to catch up with U.S. achievements, responded by proposing a plan without international control of atomic energy.

The United Nations Atomic Energy Commission (UNAEC), established on January 24, 1946, evaluated the American and Soviet nuclear plans; in July, the United States exploded at a Pacific atoll two "Fat Man" plutonium-implosion bombs of 23 kilotons each to test the effects of nuclear weapons on warships. The Joint Chiefs of Staff established an Army-Navy Subcommittee, chaired by General LeMay, to select U.S. as well as Axis warships, to decide how best to locate the vessels with regard to hazards and risks, to determine what they would carry, and to arrange for logistical support. LeMay wanted General Groves to lead the tests, named Operation Crossroads, but the JCS and President Truman chose Vice Admiral William H.P. Blandy, the Deputy Chief of Naval Operations for Special Weapons, to direct Army/Navy Joint Task Force One. Bikini Atoll and its 240-square-mile lagoon, located east of Enewetak in the northern Marshall Islands, became the site for three planned nuclear tests. Navy Secretary Forrestal and Acting Secretary of War Kenneth C. Royall, previously Patterson's Under Secretary, urged Truman to authorize the tests; he agreed on January 10, provided they were unbiased. Five days later, the President insisted that the United States be the U.N.'s sole trustee for Bikini and the remainder of Pacific Islands formerly held by Japan.

Robert Oppenheimer, and a number of other atomic scientists, some of whom petitioned Truman to prevent dropping the bombs on Hiroshima and Nagasaki and then endorsed the McMahon bill, protested the Bikini tests as an unscientific and unnecessary but to no avail. Truman, convinced by Forrestal and Byrnes that the tests were required for national defense, agreed to delay them until the Council of Foreign Ministers completed their latest meetings in Paris. On March 25, 4 days after the USAAF established the Strategic Air Command (SAC), the Tactical Air Command, and the Air Defense Command, the President appointed an

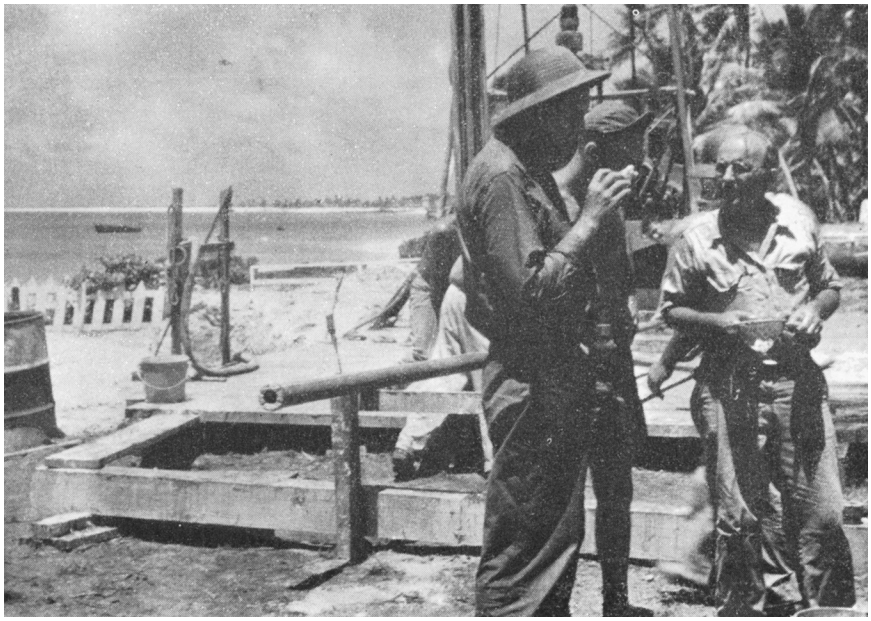
This "1500 Holemaster" rotary drill rig and its crew were supplied under contract to the U.S. Navy by the George E. Failing Supply Company. USGS and Navy scientists advised crew members as they completed three shallow and two deep holes on Bikini Island in 1947. Evaluations of the fossils and sediments in cores from these holes formed part of the scientific resurvey that followed biological and geological investigations done in 1946 before atomic tests were conducted during Operation Crossroads at the Marshall Islands' Bikini Atoll in the west-central Pacific Ocean. (Photograph from Schultz, 1948, pl. 4 [upper half].)

Evaluation Committee for the Atomic Bomb Tests, chaired by Senator Carl Hatch and including Karl Compton but not James Conant, who refused to participate, or Oppenheimer, who resigned. Baruch told the UNAEC on June 14 that successful tests at Bikini would bolster the United Nations and promote international law, and invited each UNAEC-member nation to send two observers.

Navy Secretary Forrestal joined Admiral Blandy in his flagship *Mount McKinley* along with W. Stuart Symington, the former Surplus Property Administrator and now the Assistant Secretary of War for Air; Brigadier General Kenneth Nichols, who represented General Groves; and other invitees. Other observers of the tests of two of the seven operational weapons then in America's nuclear arsenal included a Soviet physicist and Major General Semen P. Aleksandrov, a Soviet geologist who led uranium exploration in Beria's bomb project. In Test Able, on July 1, a B–29-delivered bomb burst nearly 520 feet above the lagoon. In Test Baker, on July 25, the second device exploded 90 feet below its surface. The bombs combined to sink or damage many of the 92 anchored and fully loaded U.S. capital ships, cruisers, destroyers, submarines, large transports, and landing craft and the 1 German and 2 Japanese combat vessels that America received as war reparations. Twenty-two of the 95 test vessels were lost and the others irradiated to dangerous or lesser degrees.

About 42,000 military and civilian personnel, among them some 550 scientists, participated in Operation Crossroads.[83] Commander Roger R.D. Revelle, Director of the Scripps Institution of Oceanography (SIO) but on active duty with the Navy since 1941, led Crossroads' oceanographic and geophysical studies of Bikini's physical environment and its biota. The investigations included a seismic-refraction survey of the atoll, its lagoon, and the waters surrounding the Marshalls. Specialists participating in the investigations represented the SIO, the Woods Hole Oceanographic Institution (WHOI), the Army Engineers' Intelligence Division, the Naval Ordnance Laboratory, the USGS, the Smithsonian Institution, and several universities.

The USGS contingent in Crossroads included Assistant Chief Geologist Harry Ladd, William Rubey, Joshua Tracey, Parker Trask, the University of Rochester's J. Edward Hoffmeister, the Colorado School of Mines' J. Harlan Johnson, Cornell's John W. Wells, and Kenneth O. Emery, of the University of Southern



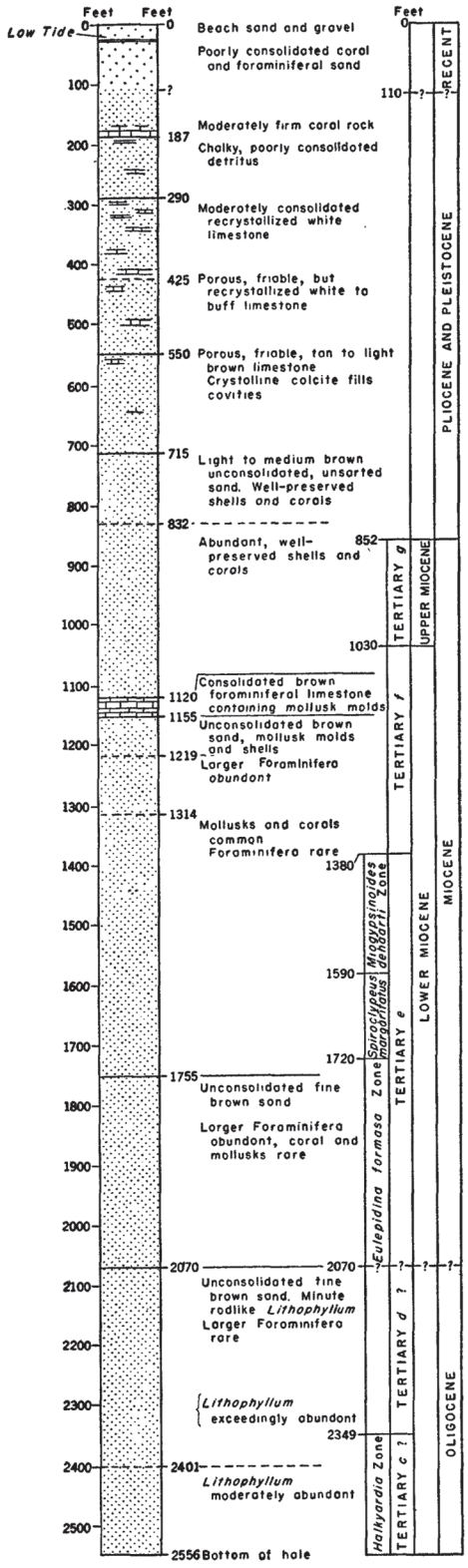
Oceanographer Roger Randall Dougan Revelle (1909–91, at left) and geologist Harry Stephen Ladd (1899–1982, at right) are shown examining fossils from one of the deep wells drilled on Bikini Island during the scientific resurvey in 1947. Cores returned specimens of calcareous algae, corals, foraminifers, and mollusks. Commander Revelle (U.S. Naval Reserve) was on leave from Scripps Institution of Oceanography and had been the first chief of the Office of Naval Research's Geophysics Branch. Revelle had led the oceanographic and geophysical studies during Operation Crossroads at Bikini Atoll in 1946. Ladd, as USGS Assistant Chief Geologist for Basic Sciences (1946–49) led Crossroads' geologic studies, organized the Pacific Geologic Mapping Program, funded by the Army Engineers, and began deep drilling on Bikini in 1947, in part to test the Darwin-Dana theory of atoll formation. (Photograph from Schultz, 1948, pl. 4 [lower half].)

California (USC). Ladd had just completed a 6-months' evaluation tour of the agency's work in the Pacific—in Japan, the Philippines, Guam, and Okinawa—when Nolan and Bradley assigned him to manage the geologic portion of the pre-explosion studies for Crossroads. Ladd and Tracey studied the surface geology of Bikini's islands and reefs, Emery looked at the subsurface geology, and WHOI oceanographer Charles C. Bates concentrated on the atoll's beaches. Hoffmeister (who earlier worked with Ladd on Fiji's geology and coral reefs), Wells, and Johnson collected and analyzed Bikini's corals and calcareous algae.

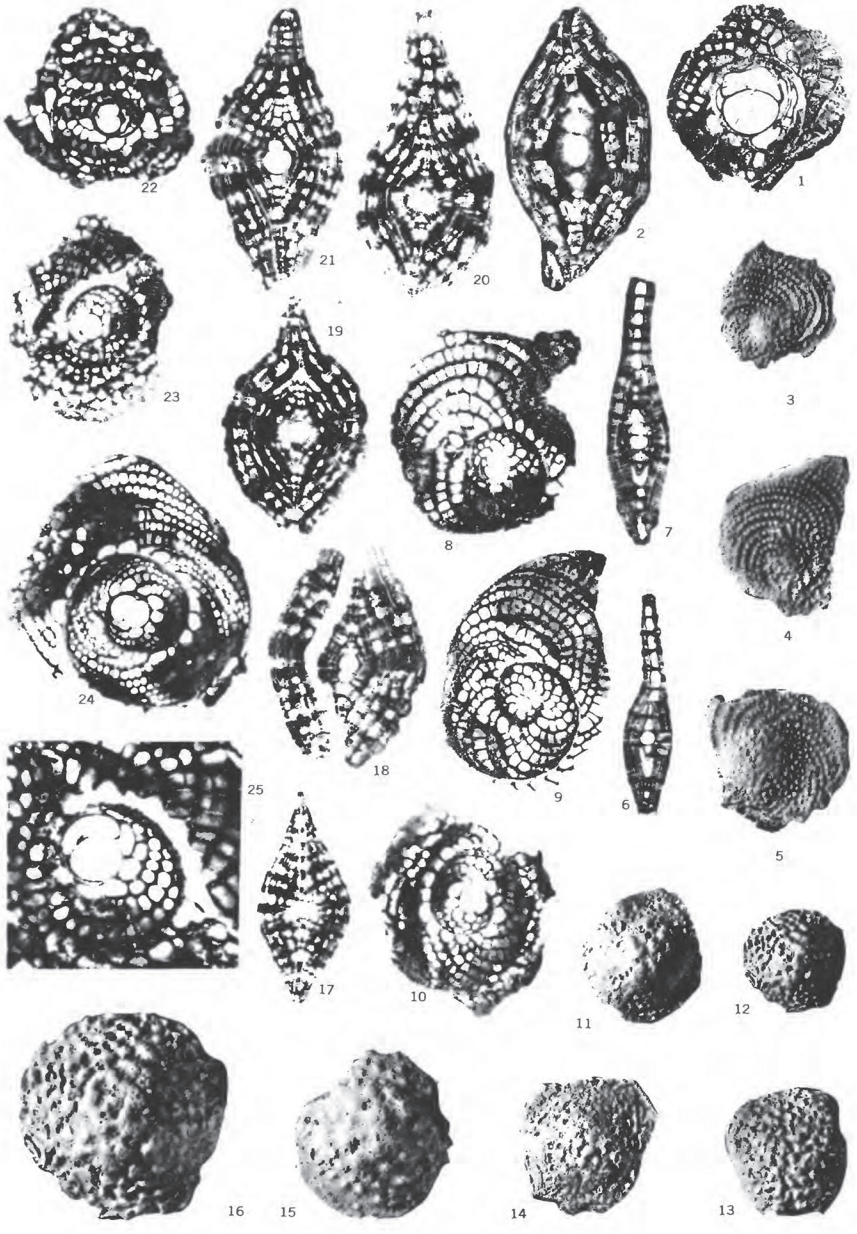
On July 15, 1947, Ladd and Tracey returned to Bikini for a 6-week resurvey of the effects of the 1946 explosions, shock waves, and fallout on the atoll and surrounding waters. Geologist Gordon G. Lill had succeded Revelle as head of the Geophysics Branch of the new Office of Naval Research (ONR) and now served as a consultant to military research and development. Lill accompanied Ladd and Tracey and extended Emery's work. Ladd and the other geologists supervised the rotary drilling, by industry personnel aided by Seabees, of five test wells on Bikini Island to provide a greater understanding of the atoll's geologic history, produce a more accurate base for the seismic studies and the ONR–USGS aeromagnetic survey later in 1947, and test the Darwin-Dana theory of reef development in response to ocean-bottom subsidence.

Drilling on atolls began early in the 1830s with a shallow excavation by an auger operated by the crew of a British merchant ship. Early in 1840, a party from Commander Edward Belcher's HMS *Sulphur* reached a depth of 45 feet during a 2-month boring on Bow (now Hao) Island in the Pacific's central Tuamotus (now in French Polynesia).[84] Charles Darwin, influenced by Charles Lyell's ideas about coral rims and submerged volcanic craters in the initial volume of Lyell's "Principles of Geology" of 1830, studied several atolls in the Pacific and Indian Oceans while accompanying Captain Robert FitzRoy's round-the-world survey in HMS *Beagle*.[85] In April 1836, the ship's dredges at South Keeling Island (probably now South Island [Pulau Atas] in Australia's Territory of the Cocos Islands) recovered no live corals below 120 feet, where light penetration limits the depths to which shallow-water corals, and their zooxanthellae (algal symbionts), can flourish. A Sydney newspaper's account of Darwin's new concept of atoll development in turn swayed James D. Dana, the Yale geologist-zoologist accompanying Navy Lt. Charles Wilkes' U.S. Exploring Expedition.[86] In 1840–41, Dana examined reefs in the Fiji group and Funafuti, Tarawa, Makin, and other atolls before his ship left for Hawaii. Analyses published by Darwin in 1842 and by Dana in 1849 proposed a multistage development of atolls in which coral growth kept pace over millions of years with the sinking of the sea floor beneath volcanic islands. Later in the 19th century, John Murray (who participated in the global voyage of HMS *Challenger* during 1872–76), Alexander Agassiz, Reginald Daly, and William Davis added their ideas to the debate about the origin and history of atolls. Ladd and Hoffmeister favored Agassiz's antecedent-platform theory as the causal mechanism for coral upgrowth rather than the Darwin-Dana idea of ocean-bottom subsidence, sea-level fluctuations, stable-island solution, glacial-control, or other explanations.[87]

As only deeper wells could test the Darwin-Dana model and the alternatives, Darwin continued to hope "that some doubly rich millionaire" would fund borings "in some of the Pacific and Indian atolls, and bring home cores for slicing from a depth of 500 or 600 feet."[88] No magnate stepped forward, but, in the 1890s, Oxford's geologist-paleontologist William J. Sollas suggested to the Royal Society of London (RSL) that it sponsor such a boring. The RSL formed a Coral Reef Committee, chaired by Sollas and including University of Sydney geologist T.W. Edgeworth David, that chose Funafuti as the site, with drilling funded by academic, commercial, government, and private benefactors. In 1896, Sollas' party drilled to 105 feet. David led a new team in 1897; its 25-ton, coal-powered,



◀ This stratigraphic section of drill hole 2B, the deepest of the five wells drilled on Bikini Island in 1947, ended at a depth of 2,556 feet in what Harry Ladd and his colleagues termed Oligocene(?), or possibly upper Eocene, reef sediments. That depth exceeded by 1,140 feet the deepest well in the Pacific, the one drilled by the Japanese on Kita-daito-jima in 1936, but the core record from Bikini hole 2B left unconfirmed the Darwin-Dana model of coral reef development. (From Emery, Tracey, and Ladd, 1954, fig. 35; see also Ladd, Tracey, and Lill, 1948.)



These large foraminifers were recovered from marine sediments from hole 2B drilled on Bikini Island in 1947. Figures 10–25 include external views and median and transverse sections of specimens of *Spiroclypeus margaritatus* (Schlumberger). These marine protozoans, with multichambered endoskeletons known as "tests," occurred in the faunal zone between 1,590 and 1,720 feet, whose sediments were assigned to the lower Miocene. The petroleum industry depended on data from foraminifers and other microfossils to determine the relative ages and correlations of rock and sediment samples from well cores. (From Cole, 1954, pl. 206; figures 1, 2, 6–10, and 16–24 originally shown at × 20; figures 3–5 and 11–15 at × 10; and figure 25 at × 40.)

diamond-drilling rig, owned and operated by New South Wales, reached 698 feet. In 1898, David's teammates extended the main boring to 1,114 feet but without encountering bedrock. The drillers at Funafuti recovered 384 feet of cores—mostly coralline, foraminiferal, and algal deposits in reef limestones overlying dolomitic limestones—assigned later to the Pleistocene and Holocene Epochs. The corals' well-known shallow-water and reef-forming nature—some of them still lived at Funafuti—confirmed subsidence when the core records and analyses appeared in the RSL report in 1904.[89]

Subsequent drilling elsewhere in the Pacific also did not reach basement rock. In 1936, the Japanese completed a hole to a depth of 1,416 feet on Kita-daito-jima (North Borodino), an island in the Daito-jima group some 200 miles east of Okinawa and 70 miles north of the Tropic of Cancer. The Japanese well descended through dolomitic limestone into mostly Miocene-age reef limestones without

reaching bedrock. Neither did Ladd's five drill holes on Bikini in 1947 reach basement, but well 2B bottomed out "at 2,556 feet in [Oligocene] unconsolidated fine sand,"[90] when the crew ran out of drill pipe. The accompanying aeromagnetic survey, by Fred Keller, Jr. (of the USGS), and Leroy R. Alldredge and W.J. Dichtel (from the Naval Ordnance Laboratory [NOL]), used a Navy PBY–5A Catalina seaplane reconfigured for a tail-cone magnetometer by the Naval Air Modification Unit (renamed the Naval Air Development Center in 1947) at Johnsville, Pennsylvania. A note in *Science* for May 17, 1945, recommended using for oceanographic surveys the twin-engine amphibian, often used in Allied long-range maritime attack, patrol, reconnaissance, rescue, and supply missions. The Catalina's crew flew 8,300 miles of traverses at 1,500 feet over Bikini and surrounding waters, including those over adjacent Sylvania Guyot. The magnetic survey mapped basement materials within 5,000 feet of sea level just northeast of Bikini, and researchers estimated that the materials occurred 8,000 feet below the atoll, but, like the interpreters of the drilling results, they left the exact nature and depth still to be determined.

Major organizational changes continued throughout the USGS during the fiscal year that began on July 1, 1946, especially in its work in Alaska as the Territory assumed increasingly greater importance in the postwar world. On February 3, just 10 days before Ickes resigned, his article "Let's Open Up Alaska!" appeared in *This Week*. Ickes appealed therein for greater use of the Territory's "vast natural resources to replace some that we have expended so open-handedly during the war." Developing the Territory and populating it by "veterans and former war workers" would provide "a settled Alaska at the coming crossroads of the airways of the world." Ickes called for a Federal program to pave the way in the Territory by classifying its lands, studying opportunities for immigration, settlement, capital investment, and employment, while building roads and other infrastructure "to assure that Americans who accepted the challenge of Alaska would have a reasonable assurance of success."[91]

On May 17, as the Senate subcommittee began hearings on the USGS budget, Wrather announced that as of July 1, the Alaskan Branch's topographic-mapping facilities, commitments, and funds, all part of the Branch since its founding in 1903, would be transferred to the Topographic Branch. Wrather expected the shift to "greatly facilitate preparations for meeting our extensive mapping commitments for the immediate future" and "to carry out administration, research, and field operations with maximum coordination and economy" by standardizing all USGS photogrammetric and map-compilation procedures and equitably deploying "trained personnel and equipment." In ending the mini-USGS in Alaska that now employed some 270 persons (nearly all full time), Wrather ordered the Chief Alaskan Geologist to "act as coordinating official for integrating Alaskan topographic mapping activities with other functions in Alaska," and "assist in determining and appraising other Alaska map needs" and "in establishing schedules and priorities"[92] for surveys. On July 22, Wrather made the Water Resources Branch responsible for water-resources studies in Alaska and placed land-classification activities in the Territory in the Conservation Branch. He promised that geologic activities in Alaska would go to the Geologic Branch as soon as he established the "position of advisor and consultant to the Director on Survey affairs regarding the Territories and Island Possessions."[93] Nine days later, the 79th Congress and the President agreed to appropriate $975,000 for a geophysical institute at the University of Alaska to recognize the results of contributions by its geophysicists to the war effort, its "unique location," and the "necessity for indefinite continuation of geophysical [exploration and] research in the Arctic in the postwar period"[94] for both military and civilian purposes. The institute's director would be nominated by the university's president, chosen by the university's regents, and approved by the NAS' president.

Geologist John Calvin Reed ([Sr.] 1905–93) began working for the USGS in Oregon in 1930 but shifted to mapping mineralized areas in the Alaska Railroad belt in 1931. He returned to Alaska in 1936, participated in and supervised strategic-minerals investigations there, became Assistant Chief Alaskan Geologist in 1944, and succeeded Philip Smith as Chief in 1946. During 1946–53, Reed served as Director Wrather's Staff Scientist for Territories and Island Possessions and as Wrather's deputy on the Navy's Operating and Advisory Committees for Naval Petroleum Reserve No. 4. Reed, also a Commander, U.S. Naval Reserve, retired as Staff Coordinator in the Director's Office in 1960 and became Executive Director of the Arctic Institute of North America. (Photograph, May 1949, from the USGS Denver Library Photographic Collection as Reed, J.C. [Sr.], 849; see also Reed, J.C. [Sr.], 1980, p. 66.)

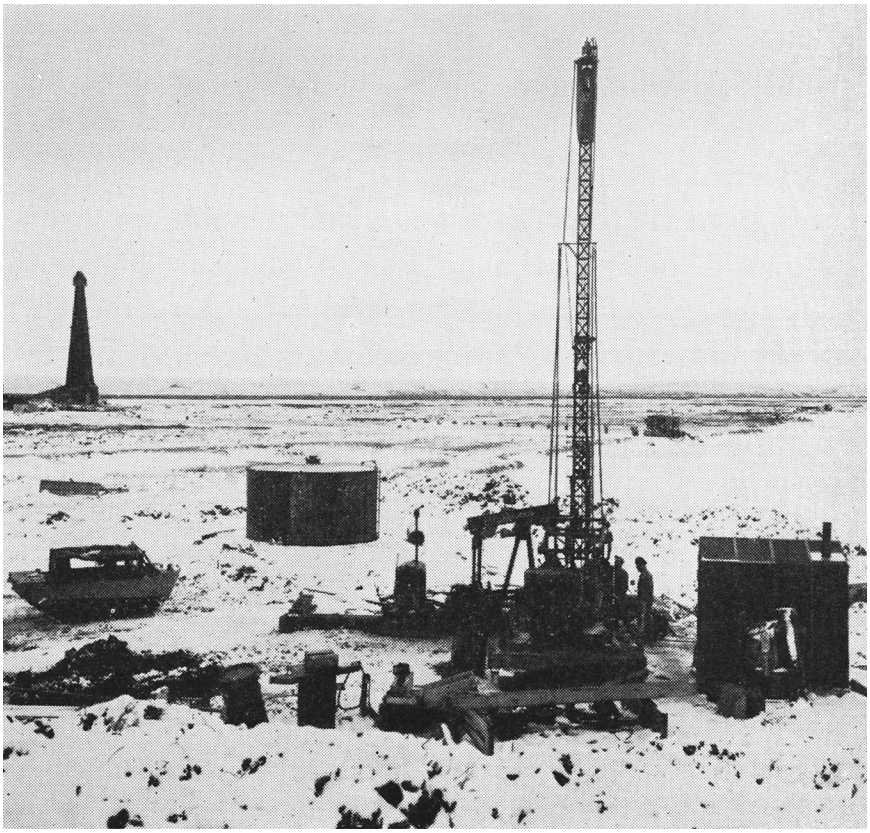
USGS geologic activities in Alaska passed formally to the Geologic Branch on September 27, 1946, when Wrather appointed John Reed (Sr.), formerly Philip Smith's deputy and now Acting Chief Alaskan Geologist, as the Director's Staff Scientist for Territories and Island Possessions. The new slot and Reed's selection for it reflected the USGS' greater concern for its role in the Department of the Interior's increasing activities abroad, as overseen by the DoI's Committee on Foreign Cooperation. Wrather named Robert E. Fellows as Reed's alternate, and Bill Bradley made Fellows also responsible for supervising general geologic mapping and studies of mineral resources within Alaska. Wrather thought that Reed, who led the Branch during the 7 months since Philip Smith's resignation, "knew more about Alaska than anyone else in the Survey"[95] except Smith. Wrather asked Reed to "recommend, advise, and consult on the formulation of Survey policies and the initiation of programs." In addition, Reed would "act as administrative deputy of the Director's Office in giving advice and recommendations to the Branch Chiefs on the planning and direction of projects," "establish and maintain liaison with other Federal agencies, Territorial offices, and municipal and commercial organizations and individuals," and "coordinate the work of the Branches."[96]

Earlier in 1946, Reed accompanied Wrather to Alaska to look at ongoing work in Naval Petroleum Reserve No. 4 (NPR–4) and elsewhere in the Territory. The Navy transferred nearly $118,000 to the USGS for mineral-resource studies by the agency in Alaska during fiscal year 1945–46, more than twice the amount provided during the previous year. USGS studies during the 1945 season gathered initial data on stratigraphic-facies changes within NPR–4. Ground-based gravimetric surveys helped to "localize areas for core drilling and seismography [electrical resistivity and seismic-reflection] work."[97] Cores from drill holes that reached depths of 580 feet at Cape Simpson and 1,816 feet at Umiat (test well 1 in 1945) disclosed oil-bearing sands and shows of oil and gas in addition to providing information on lithology, stratigraphy, and structure. Permafrost, not expected to occur below 130 feet, extended to nearly 600 feet in one of the test wells. To develop NPR–4's potential production in peacetime of 10,000 barrels per day, from estimated reserves of up to 500 million barrels, and to assure its use in a war or other national emergency, Secretary Forrestal, Assistant Secretary for Air John L. Sullivan, and Captain William Greenman agreed on September 21, 1945, to continue contracts for exploration, geophysics, photography, drilling and maintenance, geologic studies by the USGS, and air and sea transport by the Navy. They knew that completing the multiyear exploration of NPR–4 might cost more than $8 million and developing discoveries requiring production of 100,000 barrels every day to be economically viable might need more than $150 million.[98]

On December 4, 1945, Commodore Greenman, who received his single star on November 2, Wrather, Lewis MacNaughton, and Seabee Captain Bart Gillespie, later project manager for Arctic Contractors, testified in a special hearing held by the House's Committee on Naval Affairs. The committee's members reapproved the project and recommended to the Committee on Appropriations that it provide funds sufficient to carry on the program by negotiating a contract with a competent civilian contractor rather continuing to use the Seabees. At Greenman's request for "an advisory group of eminent specialists in petroleum development," Assistant Secretary Sullivan established on January 4, 1946, "an operating committee to develop policies and provide plans for Pet 4 [NPR–4]."[99] The NPR–4 committee, including Greenman, Wrather, MacNaughton, and a representative of Arctic Contractors, met during the next day. For work during 1946, they recommended continuing contract operations at the Barrow and Umiat base camps (including completing the latter's airstrip), finishing the drilling at Umiat and Cape Simpson, continuing the seismic work in the latter area and beginning it over the Meade-Inaru arch and between Simpson and Umiat, conducting a gravity survey at Point Barrow, and providing logistical support to three USGS field parties.

Wrather pointed out to Greenman that the "Navy exploration on the Reserve [also] offered a rare opportunity for conducting research on a variety of Arctic problems" if research specialists from the Smithsonian and other organizations could be attached to USGS field parties. Greenman said "that he would gladly extend any reasonable assistance to such an enterprise."[100]

Between June 1 and September 1, 1946, five USGS geologic field parties in George Gates' new Navy Oil Unit in Alaska operated within NPR–4 and just outside it in locations where the information obtained related directly to advancing the geologic interpretation of conditions within NPR–4. Karl Stefansson led a party that studied and mapped the Umiat anticline, where Umiat test well 1 was reentered and deepened to 6,005 feet and yielded 514 feet of cores. Navy Lt. Richard G. Ray, on detail to the USGS from Commodore Greenman's office, led a second group that examined the area flanking Maybe Creek, a tributary of the Ikpikpuk River. Edward J. Webber's team, including Robert E. Wallace, investigated the Meade River area and the coast at Skull Cliffs. The fourth party, led by Robert M. Chapman, looked at Mesozoic rocks in the region between the Killik and Kurupa Rivers. George Gryc's team studied the Upper Cretaceous sequences east of NPR–4, along the Sagavanirktok River, which emptied into the Beaufort Sea between Prudhoe Bay and Tigvariak Island, and at locales between Ninuluk Creek and the Kutchik River, just south of the Colville River. Additional work by Gates' Unit produced an air-photo mosaic of NPR–4. Studies of well-core and ditch samples, well logs, heavy minerals, macrofossils, microfossils, porosity, and permeability were done in the Fairbanks laboratory. Robert Chapman managed the lab after Robert Black left for Washington to lead the Alaska Terrain and Permafrost Section, one of whose responsibilities involved critiquing the Military Geology Unit's report on permafrost.

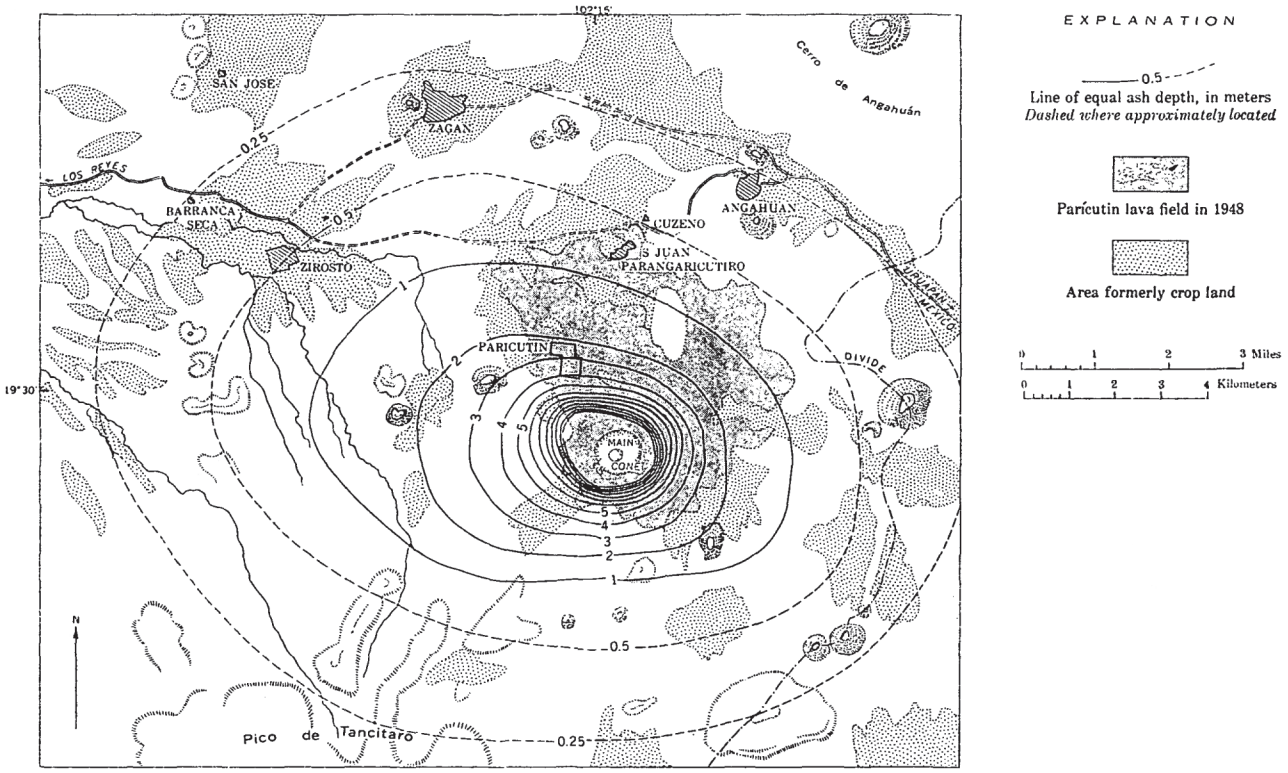


Umiat core test 1 (later Umiat test well 3), shown here in the foreground at right, was drilled in 1946 on the flank of the Umiat anticline near Alaska's Colville River and at the eastern margin of Naval Petroleum Reserve No. 4. The well "penetrated oil sands from 248 to 390 feet" and reached a depth of 572 feet. Pumping tests conducted during September–November 1947 yielded 14–24 barrels of oil per day. Umiat test well 2, in the background at left, was drilled in 1947 to a depth of 6,212 feet, or 207 feet deeper than Umiat test 1 well drilled in 1945–46. Umiat test well 2 penetrated the oil zone between 315 and 745 feet, and permafrost did not extend below 750 feet. (U.S. Navy photograph, October 10, 1947, and quotation from Reed, J.C. [Sr.], 1958a, fig. 37 and p. 77.)

Geologist George Gryc (1919–2008) and his field party 5 used this and similar small boats in 1946 in continuing the USGS exploration program of Naval Petroleum Reserve No. 4 (NPR–4) begun in 1944. Aircraft took Gryc's team to a landing strip on a lake near the headwaters of the Sagavanirktok River and east of NPR–4. The team worked downriver to the Sagavanirktok's delta and Prudhoe Bay. USGS field parties mapping and studying the geology of areas within and around NPR–4 continued the earlier practice of river traverses on Alaska's North Slope. (Photograph from the USGS Denver Library Photographic Collection as Reed, J.C. [Sr.], rjc00872, https://www.sciencebase.gov/catalog/item/51dda8c4e4b0f72b4471e90f.)

USGS airborne-magnetometer surveys of NPR–4 during the field seasons of 1945 and 1946 also added to a greater understanding of the Reserve's geology. Commodore Greenman arranged to have the Johnsville Unit install in another PBY–5A the complete magnetometer system developed by James Balsley's team. Between July 22 and September 14, 1945, Balsley and Homer Jensen began the Special Alaska Magnetic Survey (SPAMS) of NPR–4. Balsley also used the aircraft, crewed by Navy and NOL personnel, to survey known oil-producing structures in Wyoming's Bighorn Basin to gain data that would aid interpreting the results of the NPR–4 survey. Photographs from the aircraft's continuous-strip camera, tied to 1943's trimetrogon records as compiled in 1944, provided ground control; a recording magnetic variometer at Barrow provided the diurnal variation "later used to correct the magnetometer readings." Balsley and Jensen covered "almost all of the Reserve * * * from an altitude of 1,000 feet along north-trending flight lines approximately 2 miles apart." They covered the Cape Simpson area by "additional east-west trending flights," made tests "at an altitude of only 100 feet," and surveyed from 5,000 feet NPR–4's eastern half "at 12-mile intervals."[101] Greenman also arranged for the Air Technical Services Command to install short-range-navigation (shoran) equipment in the PBY–5A and supply personnel to operate it, enabling Balsley's team during March–April 1946 to survey about 9,000 square miles of the coastal waters in the Gulf of Mexico off Louisiana and Texas.

To complete SPAMS, Balsley and Jensen returned to NPR–4 in the Catalina during June 11–August 4, 1946, to cover "about 22,600 square miles, including the western part of" the 37,000-square-mile NPR–4 "and areas east, west, and south of the Reserve." Balsley, Frank M. Byers, Jr., Mary E. Hill, Darwin Rossman, Matt Walton, and Robert E. Thurmond then prepared several magnetic-intensity contour maps, one of which appeared by late August 1946 among those published in USGS Geophysical Investigations Preliminary Map 3. The NPR–4 map depicted, at about 1:725,000 and an isomagnetic interval of 10 gammas, all except 1,000 square miles of the Reserve, from the Meade River-Point Barrow area east to the Colville River and north from Killik Bend to the Beaufort Sea. The NPR–4 map "showed a regional magnetic gradient to the northeast," and one of its magnetic anomalies corresponded closely to the Umiat anticline disclosed by the surface geology. Although Balsley's team found "No consistent correlation * * * between magnetic anomalies and observed geologic structures,"[102] except at Umiat, the combined magnetic-geologic data indicated "a stable axis present [Meade River to Anaktuvuk River] during Late Cretaceous and Tertiary times" and an "anomaly of large areal extent south of Tigvariak Island [some 25 miles southeast of Prudhoe Bay] * * * worthy of further investigation."[103]



This map of Parícutin and the surrounding area in Mexico (originally at about 1 inch = 2.6 miles) shows the area occupied by crops before the initial eruption in 1943, the thickness of the ash deposit of 1946, and the area covered by lava flows in 1948, as compiled by USGS geologist Kenneth Segerstrom. USGS geologist Ray Wilcox, who also monitored Parícutin on site, added these data to his 1959 report that included data from the eruptions of Gunung Kelud (Java, 1919), Hekla (Iceland, 1947), Novarupta-Katmai (Alaska, 1912), Okmok (Alaska, 1945), Quizapú (Chile, 1932), Spurr (Alaska, 1953), and Trident (Alaska, 1952). Wilcox compiled wind-rose diagrams from upper-wind data at Alaska weather stations to demonstrate the importance of wind direction and speed (plus rainfall) in influencing the distribution of ash. He made preliminary predictions of probable falls from some Alaskan volcanoes as part of his initial assessments of volcano hazards. (From Wilcox, 1959, fig. 71, based principally on Segerstrom, 1950, pl. 1.)

On July 8, 1946, Congress and the President approved $9,710,000, of which $9.6 million would be available until July 1, 1950, to support work in the Naval Petroleum Reserves, especially "to drill and equip exploratory wells"[104] in NPR–4. The Navy hired Walter A. English to coordinate all exploration data in NPR–4 and to advise Commodore Greenman. At the fifth meeting of the Operating Committee in Washington during November 6–8, English, Gates, the geologic party chiefs, Balsley, and representatives of Arctic Contractors and United Geophysical discussed the results of their work to date, and FitzGerald "outlined the status of aerial photography of the Reserve and the mapping from those photographs."[105] The 11 wells drilled by Arctic Contractors at Umiat during the 1946 season defined a field of an estimated 100,000 barrels of recoverable crude.

Wrather, while in Alaska with Reed in 1946, met Lt. General Delos Emmons at his headquarters at Fort Richardson, just northeast of Anchorage, to discuss USGS work in NPR–4, the Aleutian Islands, and elsewhere in the Territory. Emmons invited Wrather and Reed to see Okmok on Umnak, guided by Lt. Ray Wilcox. Wrather then arranged with Emmons and Fort Glenn's commander to have Wilcox continue to keep "watch on the eruption as part of his regular duties"[106] at the post. In December 1945, Wilcox had noted "a brief resurgence of activity with a small lava flow and light ash fall [on Fort Glenn on the 16th]," but "it was apparent at an early stage that any large amount of lava would be confined within the caldera."[107] No new pyroclastic flows accompanied Okmok's eruption before it ended on December 31. The increasing volume of actual and projected military traffic in and out of Elmendorf [Air] Field, just west of Fort Richardson, and Ladd Air Field and Eielson Air Field, both near Fairbanks, the airfields and naval bases on the Alaska Peninsula and in the Aleutians, and the strategic position of the Territory contributed to the War Department's growing concern about volcanic and other natural hazards. In October 1945, the Army Engineers asked the USGS to begin systematic investigations of specific volcanoes, among the nearly 80 in that portion of the Pacific's "Ring of Fire," that posed significant threats to bases

This view, looking east, shows Mexico's Parícutin Volcano in eruption on November 7, 1947. Heavy ash covered the year-old lava. USGS, Smithsonian, and other U.S. geologists cooperated with their Mexican colleagues in monitoring and studying the volcano on site during its eruptions in 1943–52. (Photograph from the USGS Denver Library Photographic Collection as Wilcox, R.E., wire0116, https://www.sciencebase.gov/catalog/item/51ddd10be4b0f72b44721c65.)

and other facilities. In addition to the eruptions of Okmok and Tulik on Umnak, significant activity occurred in June 1943 at Kiska Volcano on Kiska (Rat Islands), in June 1944 at Mount Cleveland on Chuginadak (Islands of the Four Mountains), and in 1945 at Pavlof Volcano, northeast of the airfield at Fort Randall at Cold Bay near the tip of the Alaska Peninsula.

Geologists in Gershon Robinson's new unit for Alaskan volcano investigations[108] began field studies in the late spring of 1946, supported by Major General Howard A. Craig, General Emmons' successor as commander of the Alaskan Department, and by funds from the Army Engineers' Intelligence Division. From "1947 to 1955, the Departments of the Army, Navy, and Air Force joined to furnish financial and logistical assistance."[109] Robinson and his colleagues planned preliminary reconnaissances of many of the islands in the Aleutians and the Alaskan Peninsula, concentrating on those with significant Army, USAAF, Navy, and U.S. Coast Guard (USCG) facilities built during or since 1941. Their work centered on Attu and Shemya (Near Islands), Adak (Andreanof Islands), Umnak and Unalaska (Fox Islands), Cold Bay, and Kodiak, but Ray Wilcox was not among them. Wilcox recalled that after his Army discharge, Wrather and Reed asked him "to go back to [the] Aleutians for the Volcano Program, but I begged off. Then they offered me the job at Parícutin. Talk about luck."[110] Wilcox arrived as a "permanent" observer on September 18, 1946. Aided by Kenneth Segerstrom and others, Wilcox tracked Parícutin's activity until he completed his tour there early in 1948 and then transferred to Denver.[111]

Several other USGS geologists and field assistants did join Robinson's program. Robert Coats and his aides briefly examined Adak, Amatignak, Amchitka, Attu, Gareloi, Great Sitkin, Kanaga, Kiska, Semisopochnoi, Shemya, and Tanaga in the Aleutians during the field seasons of 1946 and 1947. Frank Simons, Donald E. Mathewson, and their aides spent the 1946 season investigating in greater detail Great Sitkin, only 20 miles northeast of the bases on Adak. Frank Byers studied tiny Bogoslof Island, north of Umnak, an important landfall long used by navigators in the Bering Sea. Bogoslof Volcano's last eruption began in 1926. In 1946, Byers also led David M. Hopkins, Bernard Fisher, and Kenneth L. Wier in assessing Umnak, during which they mapped Okmok's crater, where cone activity resumed on July 18 and continued for several months, and adjacent parts of the island.

Geological work in the Aleutians, however, proved dangerous beyond the hazards of volcanic eruptions. Fog, williwaws, riptides, and strong currents made hazardous even regular operations from small boats off islands in the chain. On June 22, 1946, Bernard Fisher accompanied an Army Engineer lieutenant and his Aleut boatman to install an aircraft-warning beacon on and study the geology of Ship Rock, an islet a little more than a mile off Fort Glenn in Umnak Pass. They drowned when their craft overturned as they tried to land on the islet.[112] After Wier left Alaska in December to join Harold James' investigation of Michigan's Precambrian iron deposits, Byers continued to study Umnak in 1947. Howard A. Powers, on detail from the USGS Hawaiian Volcano Observatory (HVO), where Gordon Macdonald replaced him on the staff, took charge of the third year's work on Umnak in 1948. George Kennedy and Matt Walton studied Pavlof Volcano in 1946. Howard H. ("Hank") Waldron and seasonal assistant Donald R. Nichols evaluated in 1947 Frosty Peak, also near Fort Randall and its airfield. Military funds continued to aid those efforts.

The Aleutians' natural hazards included earthquakes and tsunamis, as well as volcanic eruptions. Seismic shocks occurred frequently offshore in the Aleutian Trench, and those stronger than Richter magnitude 6.5 could, and some did, generate destructive tsunamis, the huge seismic sea waves the Japanese named "harbor waves" to emphasize that low heights at sea belied their slowing speeds, increasing amplitudes, and decreasing wave lengths when reaching shallow water and beginning to release their energy. Early on April 1, 1946, an earthquake of

surface-wave magnitude 7.8 was generated about 15 miles below an epicenter nearly 90 miles south of Unimak Island and spawned tsunamis.[113] One initial wave quickly reached Unimak, rose to a height above 90 feet inshore, and struck Scotch Cap at the island's southwestern tip.[114] There, the USCG operated a 60-foot-tall and steel-reinforced concrete lighthouse built in 1940, on a ledge more than 30 feet above sea level, to replace the older wooden structure that since 1898 had guided ships traveling to and from Nome. The tsunami destroyed the lighthouse, killed the five coastguardsmen who serviced the 80,000-candlepower light, and damaged the direction-finding station located on the plateau above, where the run up strewed debris 115 feet above the sea. The companion lighthouse at Cape Sarichef, on Unimak's northwestern tip, survived to continue to warn ships of the dangers while traversing Unimak Pass until a new lighthouse was built at Scotch Cap.

Other waves generated by the 1946 earthquake traveled at nearly 500 miles an hour southwest toward the Hawaiian Islands. The seismic sea waves reached the volcanic chain within 5 hours, rose inshore to heights of as much as 55 feet, and struck the northeastward-facing coasts of Oahu, Hawaii, and other islands. The surges reached 40 feet above sea level, killed 160 people, injured an additional 160, caused some $25 million in property damage throughout the islands, and devastated Hilo and the Waipio and Pololu Valleys on the main island and Waikolu Valley on Molokai. The U.S. Coast and Geodetic Survey (USCGS) established a tsunami-warning system for the Hawaiian Islands that began operations in 1948. Its network included seismological observatories at Honolulu (headquarters), College and Sitka in Alaska, and Tucson in Arizona and tide stations at Hilo and Honolulu, on Attu and Adak, at Dutch Harbor and Sitka, and on Johnston, Midway, and Palmyra Islands. By rapidly detecting and locating earthquakes, determining if they could cause tsunamis, and, if so, accurately predicting their arrival times, the USCGS intended its new Seismic Sea-Wave Warning System to alert civil and military authorities in Hawaii and in the Trust Territory of the Pacific Islands.[115] The Department of Commerce's Weather Bureau established the Pacific Tsunami Warning Center at Ewa Beach, west of Honolulu, in 1949.

These views of the U.S. Coast Guard (USCG) lighthouse at Scotch Cap on Unimak Island in the eastern Aleutians show the site before (above) and after (below) the magnitude 7.8 Aleutian Islands earthquake and subsequent tsunami of April 1, 1946. The tsunami obliterated the steel-reinforced concrete lighthouse and killed five coastguardsmen. The tsunami struck the Hawaiian Islands about 5 hours later, killing 160 people and causing about $25 million in property damage. In 1948, the U.S. Coast and Geodetic Survey established at Ewa Beach on Oahu the Seismic Sea-Wave Warning System (later Pacific Tsunami Warning Center). (USCG photographs, from National Oceanographic and Atmospheric Administration, National Geophysical Data Center.)

Late in the summer of 1946, as USGS personnel continued their work in Alaska, Secretary Krug appointed a committee to examine the often troubled relationship between the USGS and the USBM. The committee recommended assigning to the USGS the functions of physical exploration for and the evaluation of mineral resources. Krug agreed and ordered the shift, effective July 1, 1947. Reassigning these functions to the USGS required adjusting the agency to merge broadgage mapping and research on mineral deposits with the two new responsibilities. On July 23, 1946, Congress and the President agreed to amend the act of June 7, 1939, to provide for acquiring and retaining additional stocks of certain deficient or insufficiently developed strategic and critical materials, and encouraging their conservation and development from U.S. sources, to prevent "a dangerous and costly dependence"[116] on foreign supplies during national emergencies when the lack of these resources would detract from the common defense. For these purposes, the new law authorized the USBM and the USGS "to make scientific, technologic, and economic investigations" concerning the "ores and other mineral substances found in the United States or its Territories or insular possessions,"[117] with the goals of determining inadequacies in domestic sources, devising new methods for utilizing low-grade ores, and developing substitutes. In September, Bradley set up a committee of geologists, drawn from the field and administrative staffs of the Geologic Branch, to make specific recommendations.

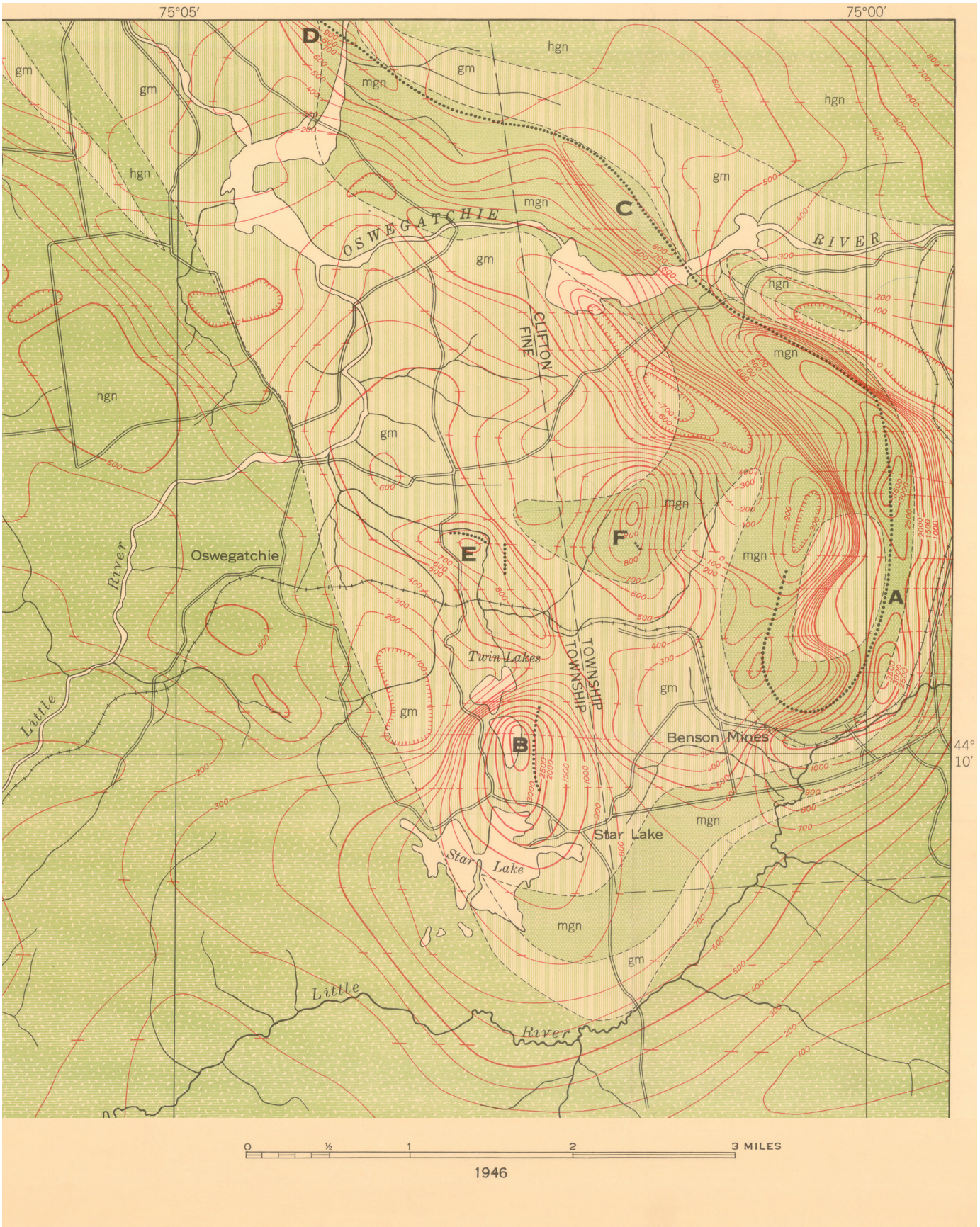
On October 30, 1946, Acting Secretary Oscar Chapman transferred the USBM's Division of Geophysical Exploration back to the USGS, its home during 1936–42. In the USGS, the ex-USBM Division's "functions, personnel, equipment,

property, and office space"[118] became, as of November 15, part of the Geologic Branch's Section of Geophysics.[119] Henry Joesting replaced Balsley (effective March 25, 1946) as Acting Chief of the Branch's expanded geophysics program; the change gave Balsley more time for research. In the Geophysics Section, Joesting and Balsley worked in and from the Army Map Service's building in Washington; Balsley led the section's airborne-surveys unit, while Joel H. Swartz, at the Baltimore office, directed the ground-surveys unit. Joesting's Section received $150,000 for a year's work, of which $105,000 supported magnetometer surveys, but he estimated on August 7 that the Section would require at least $334,000 in subsequent fiscal years.

In other administrative changes within the Geologic Branch, Bradley and Wrather combined the Section of Chemistry and Physics and the Section of Petrology to form a Section of Geochemistry and Petrology on April 30, 1947. They returned Waldemar Schaller and Clarence Ross, at their requests, to full-time research and designated F. Earl Ingerson, who shifted to the USGS from the Carnegie Institution of Washington's Geophysical Laboratory, as Chief of the new Section. Edwin McKnight replaced Charles Park, Jr., as Acting Chief of the Geology of Metalliferous Deposits. Ralph Van Alstine succeeded Josiah Bridge as head of the Geology of Nonmetalliferous Deposits.

The Geologic Branch managed for its activities during fiscal year 1946–47 a total of about $3,114,000, nearly two-thirds of which Congress appropriated directly to the USGS, for salaries and operations by its staff of 446 full-time and 35 part-time members as of June 30, 1946. Three Federal sources—the War Department, the Bureau of Reclamation, and the State Department—supplied $958,000 of the outside funds that totaled nearly $1,114,000. During the 1946 field season, Geologic Branch scientists conducted 45 major metals-related projects, about two-thirds of them on deposits of copper, iron, lead, and zinc that emphasized lead and zinc. To support and extend the ground-based studies of geology and iron deposits in the Lake Superior region resumed by Harold James in the Iron River-Crystal Falls district in December 1945, James Balsley's team began aeromagnetic surveys of several counties in Michigan's Upper Peninsula west of Marquette. Balsley and Arthur Buddington also planned to continue their study of New York's Adirondacks region, augmented by aeromagnetic surveys extending those begun in 1945. Nonmetallic mineral deposits investigated during 1946–47 included fluorspar, pegmatites, and high-alumina clay. Ralph Van Alstine and other Branch geologists continued wartime studies of fluorspar in seven States, many in cooperation with State organizations and the USBM. Investigations of pegmatites containing beryllium, feldspar, lithium minerals, mica, and tantalum, also begun during those years, were now curtailed, but USGS geologists completed reports on these deposits in six States and advanced the remaining reports. Branch geologists also continued field surveys designed to aid the search for new deposits of talc. Some of the $343,000 the Geologic Branch received from the USBR supported five projects—three on major metallic mineral resources, one on nonmetallic mineral resources, and one on construction materials—in the Missouri River Basin as part of Interior's development program.

Early in 1947, the U.S. Atomic Energy Commission asked the USGS to plan a project aimed at increasing the reserves of uranium ore in the United States. In April, as the Senate finally confirmed David Lilienthal as AEC Commissioner, USGS geologists Richard Fischer and Arthur Butler, Jr., submitted a two-part scheme based principally on Fischer's graduate studies at Princeton of sedimentary ore deposits in the Southwestern United States and especially those on the Colorado Plateau. During 1939–45, Fischer led USGS work on vanadium in Colorado and Utah. He also assessed global uranium resources for the OSRD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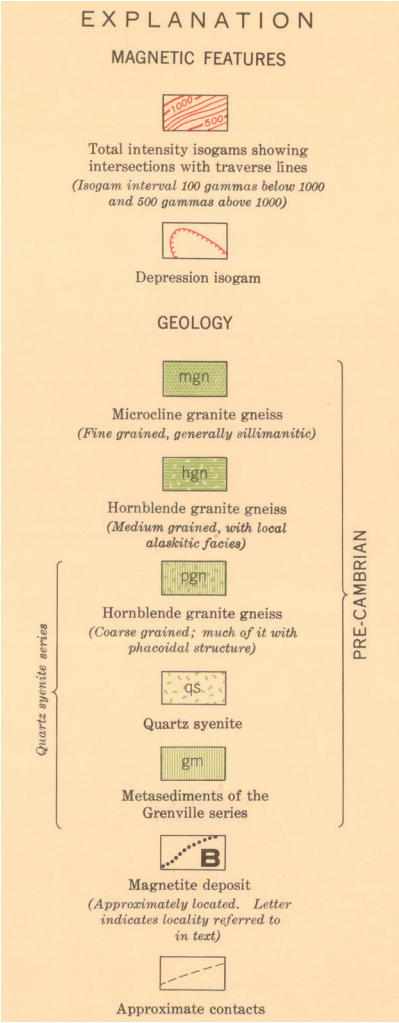


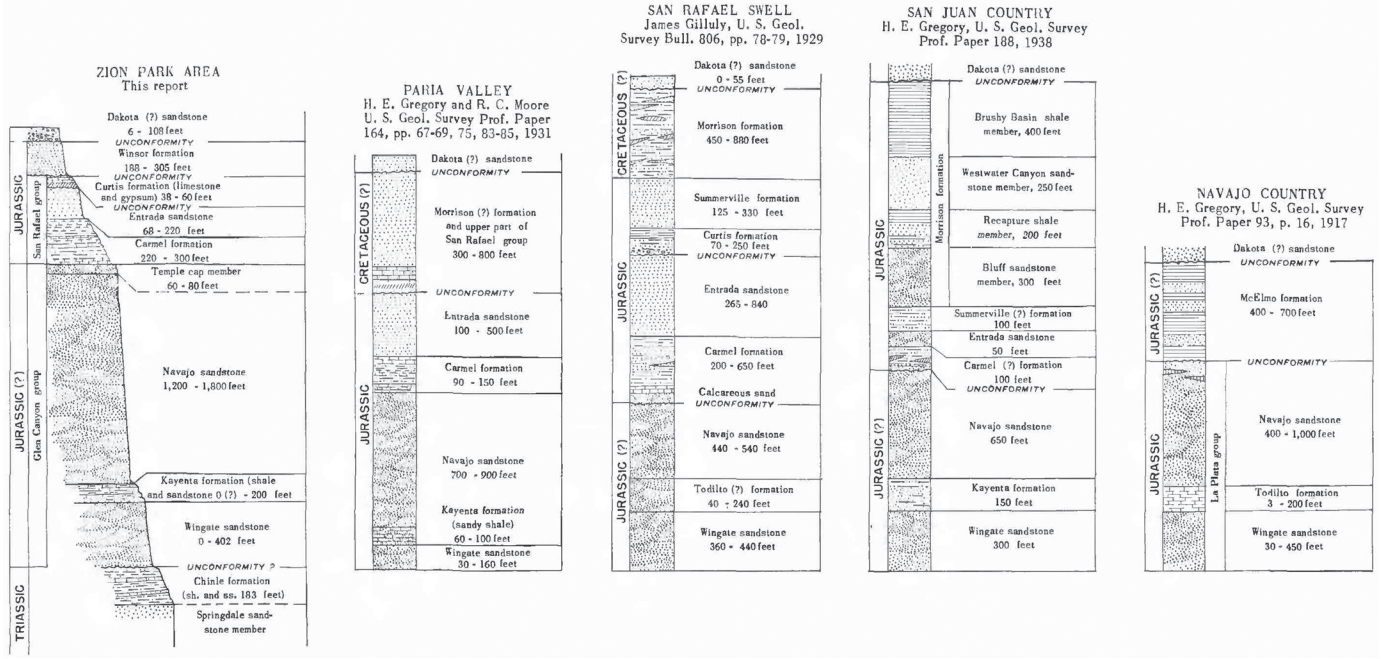
This aeromagnetic map (originally at 1:31,680) shows the total magnetic intensity (in isogams) at an elevation of 1,000 feet above the surface for a portion of the Oswegatchie quadrangle of St. Lawrence County in north-central New York. In May–June 1945, USGS geophysicists James Balsley, Jr., Cleaves Rogers, and Darwin Rossman, with E.M. Canfield of the Aero Service Corporation, conducted east-west traverses, at quarter-mile intervals (for the northern half of the mapped area) and half-mile intervals (for the southern half) of about 3,170 square miles of magnetite-bearing rocks in the Adirondacks of northern New York. William Dempsey (Sr.), Herbert Hawkes, Jr., Mary Hill, and Jack L. Meuschke compiled the magnetic data. Arthur Buddington and Benjamin Leonard provided the geologic base map, by which Balsley's team ground checked their magnetic data. They concluded that the "high-intensity anomalies and strong magnetic gradients" correlate closely "with most of the strong anomalies on the surface" and the "broad magnetic trends" correlated "with regional geological features." Magnetic anomalies shown by symbols on this part of the map include: Benson Mines (A), Twin Lakes (B), Benson Mines Extension (C), Skate Creek (D), Twin Lakes Stream (E), and Anderson (F). The map was the first published in a new series of USGS Geophysical Investigations (GP) Maps. (From Balsley, Rossman, and others, 1946.)

in 1942, contributed to the USGS report to the MED in 1943 that described the vanadium-uranium deposits in carnotitic sandstones on the Colorado Plateau as the only known U.S. occurrences with "significant potential," and emphasized examinations of uranium deposits after May 1944 at the MED's request. For the Army Engineers in 1945, Fischer aided examinations of German ores and their uses and assessed that country's engineering and military geology sites, work, and personnel. Fischer and Butler now suggested a renewed program of exploration to be guided by geologic information already gained and by new field surveys that would be supplemented by Geiger scintillation counters to detect and measure radiation. They expected the contract diamond drilling to yield a ton or more of ore reserve for each foot drilled in areas of significant radioactivity that were not near known deposits.

The Geologic Branch's Colorado Plateau Project, supervised by Richard Fischer, began expanded operations in June 1947 from the Naturita field station, about 60 miles south of Grand Junction. Between June and November, geologists Alfred L. Bush, Frederick W. Cater, Jr., Lawrence Craig, Donald H. Kupfer, and Lorin R. Stieff joined the project. Late in the summer, USGS topographers began mapping 18 quadrangles at a scale of 1:24,000 as bases to facilitate geologic mapping, exploration, and mining operations, as well as topical and other related supporting studies. Those efforts, including drilling, continued through the fall and winter. USGS geologist Lowell S. Hilpert arrived at Grand Junction in March 1948 and directed all drilling exploration for the Colorado Plateau Project to 1954.[120] By the spring of 1948, Richard Fischer's staff, most of them new hires, grew to a total of 30 geologists. The Branch's evaluation of domestic resources of fissionable materials on the Colorado Plateau and elsewhere in the Southwest quickly encompassed fieldwork in 32 States on some 100 uranium minerals in black shales, carbonates, coals, oxides, phosphates, silicates, and other occurrences. Reconnaissance investigations of statewide areas successfully delimited locales that warranted detailed study. Research on the geophysical and geochemical properties of these materials, conducted in the field and the laboratory, yielded refined techniques of exploration and detection. Branch personnel also began long-range research on the properties of uranium and other fissionable materials.

On May 3, 1946, as the USGS continued its studies of domestic fissionable materials, President Truman's Executive order[121] terminated the Petroleum Administration for War (PAW) and transferred its funds, personnel, property, and records to Interior's Oil and Gas Division established by Secretary Krug's order on May 6.[122] Krug, responding to Truman's request for advice to the Army-Navy Petroleum Board, founded within Interior on March 29, 1947, a Military Petroleum Advisory Committee.[123] To chair the new Committee, Krug chose Max W. Ball, who led the USGS Land Classification Board's Oil Section during 1910–16, left the petroleum industry in 1944 to serve as Ralph Davies' special assistant in the PAW, and replaced Davies as head of Interior's Oil and Gas Division when Davies returned to industry 2 years later.

As part of USGS investigations of fuels during fiscal year 1946–47, members of the Geologic Branch continued regional geologic studies in 28 States to advance the intensified search for new supplies of oil and gas, aided by the airborne-magnetometer surveys by Balsley's team, mostly in cooperation with Commodore Greenman's Office of Naval Petroleum and Oil Shale Reserves (ONPR), of some 70,000 square miles over potential oil-producing areas in northern Alaska, Wyoming, New Mexico, and the Gulf of Mexico Coast. In additional collaboration with Greenman's office and with the USBM, Branch geologists reexamined the oil-shale deposits on Naval Oil Shale Reserves Nos. 1 and 3 in western Colorado to appraise the potentials and reserves of these possible substitutes for liquid petroleum. Locating much larger than anticipated resources of shale oil emphasized the need for additional similar work in large, essentially unsurveyed, areas of oil shale



Geologist Herbert E. Gregory (Yale University and USGS) compared this sequence of Jurassic strata in the Zion National Park region of southwestern Utah and northwestern Arizona, shown on the far left of the correlation diagram, with equivalent sections in four adjacent regions in Utah that he, James Gilluly, and Raymond Moore measured and published during 1917–38. Gregory's and related regional correlations in adjacent parts of Utah, Arizona, Colorado, and New Mexico by other USGS geologists became increasingly important by providing regional-framework data after World War II as the USGS expanded its searches for uranium in the Morrison Formation and other Mesozoic strata on the Colorado Plateau. (From Gregory, 1950, fig. 25; for his correlation of Triassic formations between Zion Park and three adjacent regions, see fig. 24.)

throughout the Rocky Mountains and elsewhere. Low-rank coals were investigated as other potential sources of petroleum substitutes. Branch scientists also sought, largely in cooperation with the USBM, new supplies of coking and special-purpose coals in Alabama, Colorado, Georgia, Maryland, and Washington.

Funds from other Federal and State agencies partly supported the Geologic Branch's systematic geologic surveys and some of its special projects. Branch geologists completed maps of 13 quadrangles, depicting about 1,650 square miles, in Massachusetts and Rhode Island, and other areas in Montana, North Dakota, and Wyoming; mapping continued in another 28 quadrangles in these States and in New Mexico and Texas. In smaller scale efforts, they completed the 1:500,000 geologic map of South Dakota and continued work on a similar map of Montana. Special projects included a study of shoreline changes in Massachusetts, where the great storms of 1944–45 damaged much property, and a study of selenium occurrences in South Dakota's bedrock to delineate belts of concentrated amounts of that element poisonous to grazing stock. Edwin B. Eckel recruited Clifford Kaye and other geologists for his Engineering Geology Section, based in Denver. Eckel's geologists made detailed engineering studies of four quadrangles in North Dakota and began work on reservoir sites, landslides, mine waters, and several kinds of subsurface data of special interest to construction engineers. In cooperation with the Public Roads Administration, they also began special engineering soil maps of specific areas and systematic studies of the physical properties of rocks.

In fiscal year 1946–47, members of Eckel's Engineering Geology Section, Van Alstine's Geology of Nonmetalliferous Deposits Section, and other units in the Geologic Division also continued to cooperate closely with the Bureau of Reclamation's engineers, especially in mostly USBR-funded studies of the Missouri River Basin. Donald H. Dow, David Larrabee, and Stephen E. Clabaugh completed in 1945–46 their four-part overview, at 1:250,000, of the Missouri Valley region's minerals, fuels, and construction materials. Larrabee contributed to most of the subsequent preliminary maps, published during 1946–48 at 1:500,000 and at smaller scales, of these commodities in Colorado, Missouri, Montana, Nebraska, North Dakota, South Dakota, and Wyoming. The other authors of these maps included Clabaugh; Robert Bryson; Wilbur Burbank; Virginia P. Byers, Frank's wife

since 1945; Helen L. Cannon; Frederick Cater, Jr.; Frederick M. Chace; Elizabeth C. Fischer, who married William C. Overstreet in 1955; Elinor L. Fox; Wallace R. Griffitts; Allan Griggs; George S. Hilton; Lyman Huff; Maxwell M. Knechtel; Medora H. Krieger; Edwin McKnight; Virginia Neuschel, Sherman's wife since 1937; Ralph W. Richards; Andrew F. Shride; Helen D. Varnes, David's wife since 1943; and Robert A. Weeks.

Wrather and Bradley expected the activities of the Military Geology Unit (MGU) and its 125 members to terminate at war's end, but the Army Engineers provided funds to expand the MGU's gathering of terrain and related intelligence. In March 1946, Secretary of War Patterson expressed to Interior Secretary Krug "the sincere appreciation of this department for the outstanding cooperation furnished by the Military Geology Unit" and described the MGU's success as "an outstanding example of the feasibility of converting existing competent peacetime groups overnight to important adjuncts of the war effort without altering their administration." Secretary Patterson hoped that the MGU would "continue to function in its specialized field of intelligence, so as to provide peacetime data as well as to maintain a nucleus of personnel as a provision for increased future demands if circumstances should again become acute."[124]

Secretary Patterson's decision led to continued funding by the Army Engineers of the MGU's ongoing work in Japan and Washington and the support of new efforts in the Pacific and elsewhere. At war's end in September 1945, the MGU abandoned its plan to merge its contingent on Oahu with its group in Manila. Half of the Oahu team returned to the United States, and the rest were detailed for duty with the major American ground units assigned to occupy Japan. John H. Wiese and Sherman Neuschel joined Frank Swenson on Okinawa and then accompanied the XXIV Corps in September to Korea, where they briefly examined mineral deposits and supplied advice about construction, transportation, and water supplies in the American zone of occupation before returning to the United States in November. Charles Johnson, Bradley Myers, and John Rodgers went with the 6th Army in September to Japan. There, attached to Engineer battalions, they helped to select quarry sites and locate sand and gravel deposits for airfield and road construction near Sasebo on Kyushu and in the Kyoto-Nagoya-Osaka area on Honshu before reporting in November to the MGU group in Tokyo. Fritiof Fryxell, Morris Austin, John Collins, Allen H. Nicol, Edward Sampson, and Frank Whitmore helped to organize and operate in Tokyo the Division of Mining and Geology, one of five topical divisions in the Natural Resources Section in the General Headquarters of the Supreme Commander for the Allied Powers, and to plan surveys of Guam, Japan (including Okinawa), and Korea.

The Natural Resources Section, established on October 2, 1945, under Lt. Colonel Hubert Schenck, was designed to inform and advise General MacArthur and his headquarters staff on all matters relating to agriculture, fisheries, forestry, and mining and geology in Japan and Korea. Fryxell served in the Natural Resources Section until October 25 and returned to the United States in November. Fryxell carried with him a memorandum of appreciation, from Major General Hugh Casey, now Chief Engineer of the Army's Far East Command, recognizing Fryxell's fieldwork in the Philippines and his leadership as Director of the Intelligence Division's Research and Reports Branch. When Fryxell resumed teaching at Augustana, he agreed to continue on a part-time basis with the MGU. Arthur Spillers, now a Lt. Colonel, directed charcoal production and the other work of the Section's Forestry Division before also returning to America for demobilization. John Collins led the Section's Mining and Geology Division, including the Engineering Geology, Fuels, Metallurgy, Minerals, Mineral Economics, and Water Resources Branches, and its MGU personnel until Thomas Hendricks arrived on December 6.

The work of providing commodities essential to sustain the Japanese people and meet the needs of the occupation forces quickly involved the specialists of the Natural Resources Section and its Mining and Geology Division, augmented by commodity and other geologists, in surveys of fertilizers, coal, and other fuels. The Division gathered basic data on all metals, minerals, and petroleum to supply information on potential exports, imports, and reparations for the Paley Commission and participated in the Section's extensive study of Japanese research in the field of natural resources, particularly during the war years, to prepare comprehensive reports for future use.[125] An OSRD-led census determined that the Japanese sent about 150 geologists to study mineral resources, fuels, and construction materials, but not terrain, on the South Sea islands, in Manchuria, and in northern China. On December 16, 35 Japanese earth scientists, including 9 specialists in economic and mining geology, attended a joint meeting Schenck arranged at the University of Tokyo's Geological Institute, at which Schenck, Hendricks, Ladd, Sampson, and Whitmore presented papers. Quentin Singewald relieved Hendricks in Tokyo in the spring of 1946 when Hendricks joined the second round of the Paley Commission's travels in China. The Division of Mining and Geology also served as a conduit to provide other specialists to the Natural Resources Section, when scientists from other Federal agencies were transferred to the USGS and then sent on military orders to serve in the Section's Agricultural and Fisheries Divisions. The U.S. Department of Agriculture (USDA), as an additional cooperative effort with the USGS, established within the Soil Survey of the Soil Conservation Service, a World Soil Geography Unit at USDA facilities in Beltsville, Maryland. The new Unit, led by Arnold C. Orvedal, functioned as part of the MGU, with funds transferred by the USGS from those the agency received from the Army Engineers, to supply the soils portions of strategic-intelligence reports while also preparing a global-soils map.

Frank Whitmore succeeded Esper Larsen 3d as Chief of the MGU on July 1, 1946. While still based in Tokyo, Whitmore field checked terrain-intelligence reports, located construction materials for airfields and other sites, and compiled information on Japan's wartime gold and silver production. He then spent 2 months surveying landing beaches, ports, and highways in the southern part of Korea on assignment to the Office of the Engineer in the XXIV Corps and participated in field critiquing USGS Strategic Engineering Study (SES) 149 that assessed the peninsula's terrain. Whitmore, as Geologist in Charge of the MGU (later Section and then Branch), inherited a unit of experienced scientists and support personnel, although one significantly reduced in numbers as some members returned to academia and other prewar employers. The MGU continued to generate terrain intelligence for the U.S. military and conduct geologic mapping and engineering-geology field studies almost worldwide. In December 1946, Whitmore announced the MGU's shift "to field investigation, and the peacetime applications of military geology" to gather "first-hand information" on "economic data in occupied countries as a basis for reparations settlements" and "to prepare geologic maps of military areas" in the United States "and abroad for use in military construction work."[126] The USGS and the Army Engineers, he reported, already conducted this research in Japan, Korea, Okinawa, and the Philippines and planned for additional work in other areas of the Pacific region. Charles Johnson noted that field checks were completed for the MGU's terrain-intelligence reports for Korea, Okinawa, Hokkaido, Honshu, Kyushu, Leyte, Luzon, Panay, and Samar.[127]

As of January 13, 1947, Whitmore's unit, restyled the Military Geology Section (MGS), comprised four principal subdivisions. Geoffrey Bodman, Donald Dow, Lincoln Dryden, Fritiof Fryxell, David Gallagher, Montis Klepper, William Putnam, Louis Ray, Edward Sampson, and 17 other specialists in strategic and related studies served in Charles S. Denny's Terrain Intelligence Research Group. Gilbert Corwin, Delos E. Flint, F. Stearns MacNeil, Raymond A. Saplis, and three

other specialists formed Sherman Neuschel's Pacific Islands Mapping Group. John Collins, Lowell Hilpert, and seven other specialists served in the Japanese Mineral Resources Survey. James Balsley was the senior member in Special Projects, the fourth group, whose staff also included Arthur D. Howard, Earl Irving, and Joshua Tracey.

During 1946–47, Whitmore's MGS continued its work in the Far East, the conterminous United States, Alaska Territory, and Europe. Members of the large MGS contingent in the Natural Resources Section's Division of Mining and Geology in Tokyo prepared additional terrain reports, reviewed the Japanese literature from 1920 to 1940 about terrain in Japan, and studied some 40 specific mineral commodities, metallurgical plants and processes, potential sites for airfields, construction materials, ports, predictions of volcanism, and water resources of cities and specific areas in Japan and Korea. In Seoul, David Gallagher advised the Director of the Geological Survey of Korea (GSK) and Institute of Mining Technology; he also led a MGS field team that included Montis Klepper, William C. Overstreet, Raymond D. Sample, and their GSK counterparts. They located pyrophyllite used for DDT dust to control the spread of typhus-bearing lice and evaluated southern Korea's coals, gold, tungsten, and other mineral resources. MGS geologists Robert Laurence (in 1946) and then Earl Irving (1946–57), assigned to the General Engineer District in Manila, surveyed construction materials used to aid the rebuilding of the city and those elsewhere on Luzon, studied the groundwater resources of nearby Nichols Field, and cooperated with the Philippine Bureau of Mines to reestablish programs designed to map geology and explore for mineral deposits in the newly independent Republic.

Elsewhere during 1946–47, MGS members prepared four Joint Army-Navy Intelligence Studies of the mineral and water resources and construction materials of Argentina, south-central China, the European part of the Soviet Union, and Turkey. They also completed a large number of Special Reports and Miscellaneous Papers for the JCS, the Army Engineers, and several other organizations. Their efforts included terrain analyses and permafrost studies of four specific areas in Alaska, by Maxim Elias, Robert Wallace, and their colleagues; of clay deposits in the Virgin Islands; of Guam's geology and water resources; of trafficability and airfield sites in westernmost China's Sinkiang (Xinjiang) Province; and of cross-country movement in the Caucasus, as part of a projected global-trafficability map. To help U.S. armored-forces training, the MGS also completed a special terrain-intelligence folio of Kentucky's Fort Knox Military Reservation and vicinity for the Office of the Chief of Engineers. Louis Ray, who served with Esper Larsen 3d as a consultant to the Army's Armor Board, led a ground-studies team that included Arthur Butler, Jr., Charles Denny, Arthur Howland, and Marion Striker. The completed but unnumbered folio included map sheets describing the construction materials, geology (at 1:50,000, with a columnar section on a separate sheet), soils, terrain, and trafficability of the area. The MGS planned a similar study of Virginia's A.P. Hill Military Reservation but, at the Army Engineers' request, shifted to work on a folio about Fort Benning, Georgia, to aid infantry training there. Responding to an appeal from the Engineer Board at Fort Belvoir, Virginia, the MGS also started compiling a training manual for military geology. In Europe, MGS personnel continued fieldwork for a report about Austrian and German oil fields.

The MGS Pacific Islands Mapping Group, later also known as the Pacific Geologic Mapping Program,[128] began operations in April 1946, sponsored by General Casey's office in the Army's Far East Command. Sherman Neuschel, who arrived in Tokyo in December 1946 to lead the new group, reported to Brigadier General Herbert Loper, the Chief of Casey's Intelligence Division. The group's staff, housed initially in Casey's headquarters, later moved to the facilities of the Army Map Service-Far East in one of Tokyo's northern suburbs. The Army Engineers were responsible for constructing and maintaining bases in the western

Pacific, including those on or planned for the former German islands subsequently held by Japan under a League of Nations' mandate.[129] The State Department expressed to the Chief of Engineers its interest in a geological survey of these islands, concentrating on their economic value. Chief of Engineers Eugene Reybold, a Lt. General since April, sought and received for the mapping a delegation of authority on September 27, and an approval on October 3, from the War Department's General Staff. Reybold retired on September 30; Lt. General Raymond Wheeler, who attended the Japanese surrender ceremonies at Singapore, replaced Reybold on October 4. Existing funds, General Wheeler decided, would cover the new group's efforts; he transferred them under the agreement with the USGS for fiscal year 1945–46 and continued the work as part of the understanding for fiscal 1946–47 signed on August 28, 1946.

Harry Ladd suggested that long-term geologic mapping of the islands of the Western Pacific, with emphasis on the mandated islands, be conducted in two phases. Initially, the Army Engineers would provide $600,000 for and supervise the new group and its program, but then USGS appropriations would provide $1 million each year for the next 10 years. The program would produce military geology studies for each island or group of islands, with maps at scales of 1:25,000 or 1:50,000, published by the Engineers. To the program's primary geology and soils components would be added botanical, climatological, hydrologic, marine-geology, and mining studies; some of them would be published by the USGS. In January 1946, Ladd arrived in Tokyo on his tour of inspection. He discussed his scheme with General Loper and other officers on General Casey's staff before visiting Okinawa, Guam, and several of the other targeted islands, and participating in Operation Crossroads. While Ladd traveled, General Wheeler asked the War Department, through General MacArthur, to implement the mapping program. Casey and Loper approved continuing the group's initial work on Okinawa.

MGS personnel in Japan compiled from the literature a preliminary special report on the mineral resources of the former mandated islands, but the USGS did not have sufficient geologists in the Far East to conduct the island-mapping program. Thomas Hendricks placed a note in the Army's *Pacific Stars and Stripes* asking geologists in uniform in the Pacific to request their service discharges in Japan and then join the demonstration project on Okinawa, now being developed as a principal American military base. USAAF Major Warren F. Fuller and 2d Lieutenants Harold W. Burke and Gilbert Corwin and Army 2d Lts. Delos Flint and Raymond Saplis did so. Corwin also arranged to drive Ladd around Okinawa. In April 1946, initial field-party chief John Rodgers, Burke, Flint, and Fuller began mapping Okinawa's 454-square-mile area and its manganese, sulfur, and other mineral deposits. In September, Saplis and Corwin joined the USGS team based at Naha. By January 1949, geologists McClelland G. Dings (also chief), Maxim Elias (also chief), Samuel S. Goldich, Stearns MacNeil (also chief), Allen Nicol, and Henry S. Sharp served on Okinawa. Clarence S. Coleman, Roy W. Simonson, Carl H. Stensland, Edward H. Templin, Joseph H. Vaden, and Raymond Zarza investigated the island's soils and forests while detailed from the World Soil Geography Unit. The combined resident team completed its report on the reconnaissance and detailed mapping of Okinawa during May 1949.

While MGS fieldwork continued on Okinawa, Josiah Bridge, Acting Chief of the Geologic Branch's Geology of Nonmetalliferous Deposits Section, and Arthur Piper, still leading the Ground Water Division's Pacific Coast operations, spent 6 months from April 1, 1946, looking at the mineral resources and water supplies of the Western Pacific islands formerly mandated to Japan. Their work formed part of an economic-appraisal expedition for the Navy by the U.S. Commercial Company, a subsidiary of the Reconstruction Finance Corporation. The MGS' work in Micronesia expanded to the Palaus and to Yap in 1947, and the MGS' special report on Guam's geology and water resources appeared that year. Charles Johnson and

Samuel Goldich gave special attention to the bauxite deposits on Babelthuap (now Babeldaob). Johnson then started studies on Yap and other islands, aided by Preston Cloud, Jr., Collins, Corwin,[130] Julia Gardner, Arnold C. Mason (also chief), and Henry Sharp, until work ended in November 1948. USDA soils scientists Paul O. Elmquist, Ralph C. McCracken, Roy Simonson, and Edward Templin participated in these surveys.

While mapping continued on West Pacific islands, the Geologic Branch expanded southward the geographical frontiers of its studies, this time to Antarctica. James Balsley and Arthur Howard, both still with the Military Geology Section's Special Projects Group, participated in the U.S. Navy's Operation Highjump on and over the southernmost continent during December 1946–February 1947. Earlier in 1946, the Navy's Operations Frostbite and Nanook, the latter led by Captain Richard H. Cruzen, began America's postwar missions in the polar regions by briefly examining portions of the Arctic. The Navy intended its next and larger effort, as Lisle A. Rose described in 1980 in "Assault on Eternity," principally to test men and equipment in another cold environment, to gain information useful for locating sites for airbases and other bases on Antarctica, and to acquire experience for future similar operations on Greenland. The Navy also planned to win its second bitter struggle with the Army over the future of naval aviation, now linked to the proposed national defense establishment. Operation Highjump would show how well the Navy could project power into the southernmost seas to meet cold war threats in those waters and future defense commitments under a proposed new treaty for mutual aid in the hemisphere. Truman attended the signing, at Rio de Janeiro on September 2, 1947, of the Inter-American Treaty of Reciprocal Assistance. The treaty formalized the recommendation in 1945's Act of Chapultepec to consider an armed attack by any nation against one American country as an assault on all of them and to provide the means to respond accordingly.

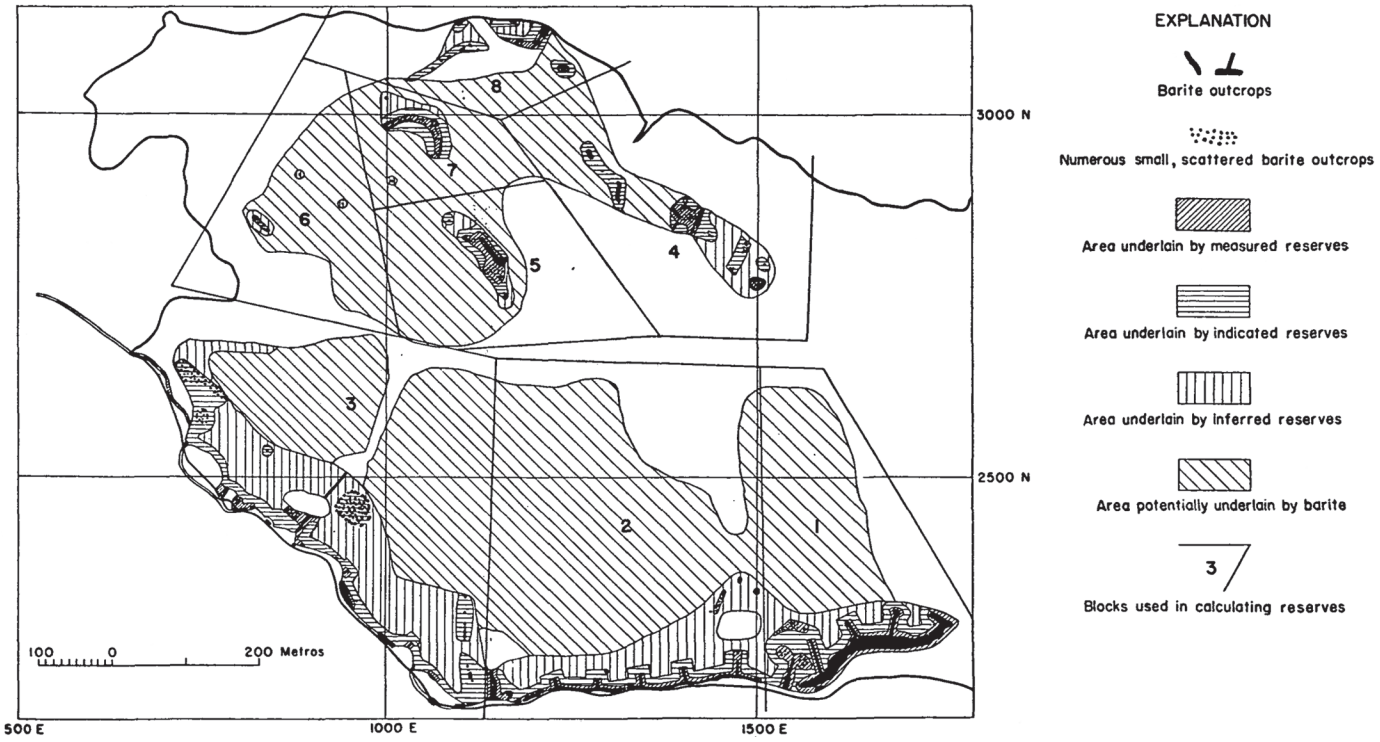
The Navy also intended its Operation Highjump to Antarctica during the austral summer of 1946–47 to increase reconnaissance and mapping coverage of the continent in support of strengthening and expanding the United States' dominion over the greatest possible expanse.[131] During 1907–43, Britain, for itself and for Australia and New Zealand, Chile, France, and Norway, claimed swaths of Antarctica; several of these areas overlapped, and their boundaries remained in dispute. On December 14, 1946, Under Secretary Acheson informed Secretary Forrestal that he approved new, but as before unannounced, claims on Antarctic lands not previously seen by U.S. personnel and those already claimed by other nations. The new paper claims would be placed in brass containers and the time and location of their deposit carefully recorded. The Navy also planned to prospect by air for uranium and other radioactive-mineral deposits, as part of studies of aerology, cosmic and solar radiation, electromagnetic propagation, general geology, geography, hydrography, and meteorology. On August 26, 1946, orders from Secretary Forrestal and Admiral Nimitz, now Chief of Naval Operations, established the Navy's Antarctic Developments Project, led by Rear Admiral Richard E. Byrd (Jr.), the younger brother of Senator Harry Byrd (Sr.) and a veteran of three expeditions to the southernmost continent since 1928–29,[132] and aided by an interagency committee in Washington. Cruzen, now a Rear Admiral, commanded the 4,700 men and 13 warships and support vessels of Task Force (TF) 68; he also led TF 68's Central Group from his flagship *Mount Olympus*. Captain George J. Dufek and Captain Charles A. Bond led, respectively, TF 68's Eastern and Western Groups; like Cruzen, they also were veterans of Byrd's earlier Antarctic expeditions.

As on Byrd's earlier expeditions, civilian scientists accompanied Highjump's Navy and Army personnel, although Admiral Cruzen thought these 24 specialists were superfluous. Paul A. Siple, a biologist turned geographer, veteran of several of Byrd's Antarctic expeditions, and Lt. Colonel in the Army Quartermaster

Corps, participated in Highjump as a scientific adviser to the General Staff's Chief of Research and Development. Howard and half of the scientists accompanied Cruzen's Central Group ships. Delayed by an unexpectedly wide and thick ice pack, Cruzen's ships, led by Coast Guard icebreaker *Northwind*, did not reach the eastern part of the Ross Ice Shelf until January 15, 1947. There, the accompanying Seabees built Little America IV and its landing strip for fixed- and rotary-wing aircraft. On January 23, the Eastern and Western Groups began explorations and overlapping mapping by trimetrogon photogrammetry of coastal regions from six Martin PBM Mariner seaplanes based on the tenders *Pine Island*, stationed off the eastern coast of Marie Byrd Land, and *Currituck*, deployed off the coast of Wilkes Land. Seven days later, Byrd's party, including Balsley,[133] flew into Little America IV in the six-wheel and ski-equipped R4D Skytrains, launched with jet-pack assistance from the new fleet carrier *Philippine Sea*. Admiral Cruzen took his three remaining ships, their crews, and Howard, out of the Ross Sea on February 6.

The first of 28 mapping-sovereignty flights from Admiral Cruzen's Central Group base over coasts and inland began on February 13, 1947, but space on these missions remained at a premium. A week later, Balsley got only a brief notice for his initial flight.[134] He quickly removed his magnetometer from one R4D and tied it down with ropes in another R4D piloted by Major Robert R. Weir. This aircraft, whose eight-man crew also included *New York Times* correspondent Walter Sullivan, flew east from Little America IV toward King Edward VII Land. When the trimetrogon cameras tripped at regular intervals, Balsley marked these events on the magnetometer's paper-roll record to match them to the photographs of strips 20 miles wide by 100 miles long. The R4D crossed the Alexandra Mountains and La Gorce Peak before turning south toward the Rockefeller Mountains and returning over Roosevelt Island to the base. While struggling for higher altitude to clear one of the ranges, Weir suggested that they lighten the load by jettisoning the magnetometer; if so, Balsley replied, they would have to throw him out as well. Balsley's intensity records indicated the locations and approximate depths to igneous or metamorphic rocks with magnetic minerals, confirming some earlier geologic observations on the ground by Laurence M. Gould, who served on Byrd's initial expedition, but the lack of such readings suggested nonmagnetic sedimentary rocks. The next day, as Weir's R4D flew south across the Ross Ice Shelf, Balsley located four new islands near Roosevelt Island, but his records again demonstrated that the magnetometer could not distinguish ice from nonmagnetic sedimentary rock; securing an accurate profile of the land under the ice required gravity and seismic studies. Byrd, Balsley, Sullivan, and the remaining men, but not the R4Ds, left Little America IV in Navy icebreaker *Burton Island* on February 23. Highjump personnel also left behind nearly 70 new U.S. claims to Antarctic territory.

The Geologic Branch, to handle the increasing requests to detail its scientists to work outside the national domain, founded a formal unit for foreign geology. On January 28, 1946, Bradley changed, as of February 1, John Dorr 2d's Committee for Cooperative Investigations Abroad into the Foreign Section. Dorr transferred at his request to field studies of the geology of nonmetalliferous deposits. As Chief of the new Section, Bradley selected William Johnston, Jr., now returned from Brazil. With USGS statutory authority (since 1938) to work in the American Republics, Johnston's geologists used the State Department's auspices and funds in making cooperative investigations during fiscal year 1946–47 of 14 mineral commodities and helping to train younger colleagues in Brazil, Cuba, Mexico, and Peru. The State Department also provided monies for training grants to two Mexican and two Peruvian students of geology. With Foreign Economic Administration funds, Johnston's geologists studied some of Bolivia's tin deposits and continued work on manganese occurrences in Cuba. The Government of Chile requested and financed a USGS reconnaissance of the mineral deposits of its Southern Archipelago and groundwater studies in the northern and central parts of the country.



This geologic map (originally at about 1 inch = 820 feet) shows barite outcrops and the extent of measured, indicated, inferred, and potential reserves of barite distributed in deposits in Cretaceous sedimentary rocks on Ilha Grande in Camamú Bay, southwest of Salvador, in Brazil's State of Bahia. USGS geologist Alfred Bodenlos examined during March and April 1946 the geology and barite deposits of Ihlas Grande and Pequena, at the request of and in cooperation with members of Brazil's Divisão de Fomento da Produção Mineral, and with the sponsorship of the U.S. Department of State's Interdepartmental Committee on Scientific and Culture Cooperation. At that time, barite was used in manufacturing several chemicals, inert fillers, oil-well drilling muds, and white paint. (From Bodenlos, 1948, fig. 3.)

The Topographic Branch's funds available for fiscal year 1946–47 totaled $6,645,000, about 23 percent more than in the preceding year, for its all-full-time staff of about 1,080 persons as of June 30, 1946. George Whitmore's Division of Research and Technical Control, while preparing new and revising existing instruction manuals for field and office procedures, investigated using electronic methods to establish geodetic control for topographic mapping. Whitmore's staff developed an assembly of electrical circuits set up and adjusted as analogs to networks of traverse or level lines, intending that adjusting surveys by electrical control would give results comparable to those found by mathematical corrections but with much less work. The polastrodial, which rapidly determined mechanically the astronomic azimuth of Polaris, the North Star, at any time and from any latitude, reduced considerably routine traverse computations. The staff evaluated, repaired, and, in some cases, redesigned and made available for experimental use or production captured German photographic equipment, including a relatively distortion free and extremely accurate aerial-camera lens. That lens so far surpassed the best lenses manufactured in the United States that arrangements were made with Bausch and Lomb to manufacture copies. Russell Bean and his colleagues also tested a wide range of plotting instruments. In coordination with other Federal agencies and the Bureau of the Budget, Whitmore's staff also made considerable progress in standardizing cartographic procedures and symbols. His Division's Special Map Section continued work on the International Map of the World, as well as transportation maps for the Public Roads Administration and the revisions of State base maps for Connecticut, Delaware, Illinois, Maryland, Massachusetts, New Jersey, Rhode Island, and Wyoming.

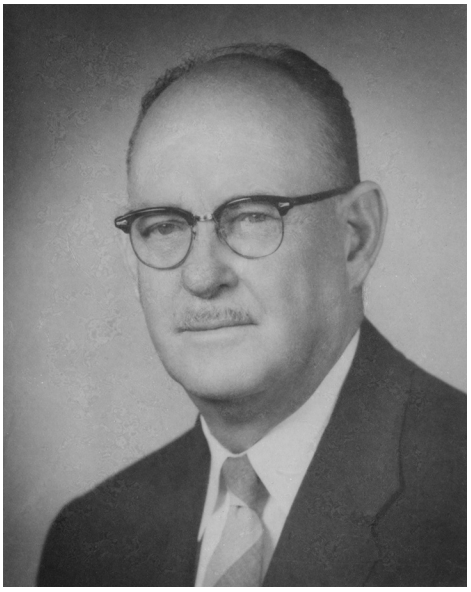
After Gerald FitzGerald's Division of Plans and Coordination reached an understanding with several other Federal agencies regarding their respective spheres of mapping activity, the USGS signed accords with the Bureau of Reclamation, the Coast and Geodetic Survey, the Forest Service, and the War Department. The Army Engineers agreed on October 21, 1946, to continue to support the USGS as the primary domestic mapping agency, under the rubric of utilizing all available

Federal capacity for this purpose before expanding War Department facilities or hiring private firms. The USGS understanding with the USBR, dated January 17, 1947, proposed to eliminate or reduce to a minimum any future special-purpose maps by requiring, whenever possible, that all mapping be done as a direct contribution to the standard-quadrangle mapping of the United States. The USBR would use USGS services in preparing all maps at scales smaller than 1:6,000, preparing specifications for proposed mapping or aerial-photographic projects, and inspecting and testing commercial-contract mapping. The Forest Service, which recently shifted from a policy of mapping irregular areas to one of mapping full quadrangles, agreed to send the material to the USGS for publication. The USCGS and the USGS agreed on March 25, 1947, to consider together devising methods to supply new or additional information on any coastal area of the United States needed by the USCGS in preparing its nautical charts. FitzGerald also reorganized the Map Information Office and broadened the scope of its services. A Survey order, issued on January 2, 1947, set policies with respect to the overall specifications for the accuracy, scales, and contour intervals of USGS standard topographic maps.[135]

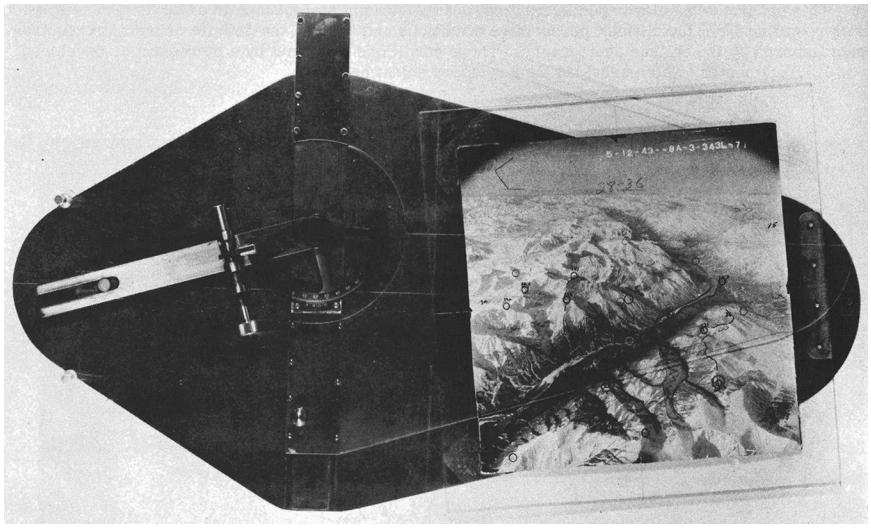
On July 1, 1946, the Topographic Branch reactivated its Rocky Mountain Division, with headquarters at Denver and Robert O. Davis temporarily in charge, to provide a "strategically located" operational unit for "much new mapping"[136] in Alaska, Colorado, Montana, and New Mexico. On the same day, all of the Alaskan Branch's topographic mapping activities passed to the Topographic Branch,[137] which founded a Trimetrogon Section, led by John Davidson, to meet the military's continuing demand for aeronautical-chart compilation done by the Alaskan Branch during the war. As "no suitable quarters were available in Denver for the Rocky Mountain unit," Wrather and Michael Straus, now Commissioner of Reclamation, agreed to join their efforts with those of other agencies in seeking congressional support and funds for remodeling buildings in the Remington Arms ammunition plant, built early in World War II about 6 miles west of downtown Denver. Wrather claimed "more space than we needed immediately"[138] in one of the buildings in the proposed Federal Center, to reserve it for use by his other branches. Topographic Branch personnel and equipment occupied a large part of Building 25; the Geologic Branch chose a smaller structure later known as Building 21. On October 1, Davis, who served to Lt. Colonel with the USAAF's Aeronautical Chart Service, was officially appointed the Rocky Mountain Engineer.[139] For the Rocky Mountain Division, Davis now secured Government-surplus office equipment and photogrammetric equipment from the Atlantic Division in Arlington, Virginia, now led by Dallas H. Watson (Albert Pike's former deputy), after Pike's retirement. Also on July 1, as part of a plan to assign the maximum work possible to the four regional divisions (including the Pacific and Central), another Survey order deactivated the Photographic Mapping Section, transferred the drafting and Multiplex units at Clarendon, Virginia, to the Atlantic Division, and shifted the remaining photo-mapping activities to "the Photogrammetry Section of the Technical Staff until such time as these functions can be absorbed by other appropriate units."[140]

When the war ended, the Topographic Branch resumed large-scale domestic mapping. By the end of fiscal year 1945–46, members of the Branch made field surveys in 35 States, completed mapping 56 quadrangles at a scale of 1:62,500 and 105 quadrangles at 1:24,000, and continued work on an additional 68 quadrangles at 1:62,500 and 109 quadrangles at 1:24,000. They also used photogrammetric methods to make topographic maps of areas covering more than 9,300 square miles and planimetric and base maps of about 10,600 square miles. They also completed a large-scale map of the Naval Oil Shale Reserves Nos. 1 and 3 in Colorado for the Navy Department and continued work on the Snake River in Idaho in connection with Columbia River development.

On May 22, 1947, Krug and Wrather formally advanced Gerald FitzGerald to Chief Topographic Engineer, replacing Thomas Pendleton, whose stroke led



Topographer Gerald Arthur FitzGerald (1898–1981) began serving with the USGS in 1917 and worked in Alaska during most of the interwar years. He led the revisions of Alaskan aeronautical charts before being commissioned as a Major (later Colonel) in the U.S. Army Air Forces (USAAF) in 1942. FitzGerald led the USAAF's Aeronautical Chart Service (1943–45) and earned a Legion of Merit (1946). He returned to the USGS late in 1945, became head of the Topographic Branch's Plans and Program Division in 1946, and succeeded Thomas Pendleton as Chief Topographic Engineer in 1947. FitzGerald and George Whitmore led the Branch's initial postwar reorganization that emphasized improved and new methods of photogrammetry and mapping to increase map production at less cost. FitzGerald retired in 1957. (USGS photograph, Public Inquiries Office 40–13; published in Lyddan, 1983.)



USGS topographer David Landen developed this mechanical topoangulator in 1944 "for use with trimetrogon photogrammetry." The topoangulator projected "photographic detail into the principal plane for elevation determination" by the transparent-plate projector. A "slide operating parallel to the principal plane of the photograph" actuated the projector and the hairline etched on it. (Quotations and photograph from Thompson, 1958, p. 12 and fig. 10; photograph originally published in Landen, 1945, fig. 4.)

to his retirement on April 1. FitzGerald retained John Staack as his Assistant. George Whitmore's Research and Technical Control Division included six Sections: Geodesy and Control Surveys (led by Ronald Wilson, whose precision photoalidade helped Charles Fuechsel and David Landen to make practical the trimetrogon-mapping system), Topographic Surveys (Charles Davey), Photogrammetry (Russell Bean), Cartography and Map Editing (Robert L. Moravetz), Special Maps Projects (Oscar Nelson), and Trimetrogon (John Davidson). Robert M. Lyddan's Plans and Coordination Division comprised four units: Map Information Office (Charles Fuechsel), Plans and Estimates Section (Earle J. Fennell), Production and Control Division (later Section, Roy F. Thurston), and Coordination and Liaison Section (Alfred C. Stiefel). After Staack retired on June 30, Moravetz became FitzGerald's Assistant Chief, Fuechsel replaced Moravetz, and Jerome O. Kilmartin succeeded Fuechsel.

During fiscal year 1946–47, FitzGerald's mappers operated in 40 States, in cooperation with 20 of them, the Army Engineers, the USBR, the National Park Service (NPS), and the TVA. They completed coverage of nearly 25,000 square miles, 16,000 of which were mapped at field scales of 1:24,000 or larger. Topographic Branch personnel also finished 45 quadrangles at 1:62,500 and nearly 300 quadrangles at 1:24,000. Published coverage of the conterminous United States at 1:24,000, begun with 3 maps of mining districts (Tombstone in Arizona and Bullfrog and Goldfield in Nevada) in 1906 and 2 urban-area sheets (of Venice and Watts in the Los Angeles Basin) in 1924, remained at 4.8 percent. Work continued at year's end on an additional 75 quadrangles at 1:62,500 and almost 400 quadrangles at 1:24,000. For the Army Engineers, Branch topographers mapped several areas and established field control for others. The USBR provided the Branch with nearly $720,000 for a major effort to support the USBR's work in the Missouri River Basin, of which less than 10 percent was covered by topographic maps suitable for water development or other engineering studies. For these purposes, USGS topographers mapped large areas in Montana, Nebraska, North Dakota, and Wyoming. Branch members also completed, at 1:31,680, the resurvey of Massachusetts and revised 55 quadrangles in California's San Joaquin Valley. For the NPS, they continued mapping Jackson Hole National Monument in Wyoming.

The Topographic Branch's Trimetrogon Section completed 628,000 square miles of entirely new compilation and another 800,000 square miles of chart revisions in practically every part of the world during 1946–47. Members of the Section made additional studies to determine the feasibility of the method for

small-scale mapping of unmapped expanses of the Western United States and aided the mapping of Bikini Atoll for Operation Crossroads. They also planned to generate maps of parts of Antarctica, by using the trimetrogon photographs the Navy took during Operation Highjump, as soon as sufficient ground control became available. Highjump aircraft flew 64 reconnaissance missions over an area estimated to be as much as 700,000 square miles, but they mapped only a tenth of that total, far less than planned, and generated few maps. The lack of oxygen equipment for the R4Ds, without which the planes could not fly above 10,000 feet, and the paucity of geodetic control on the ground prevented prompt use of the operation's 70,000 trimetrogon-photogrammetric records.

During the second Antarctic Developments Project (Operation Windmill[141]) in 1947–48, USGS topographic personnel, flying in Navy HU 35–1 helicopters from the icebreakers *Burton Island* and *Edisto* of Task Force 39, supplied some of the needed geodetic data for selected geographic features. As Under Secretary of State, Robert A. Lovett continued Acheson's policy about extending U.S. territorial claims; a dozen new markers were dropped from Windmill aircraft. Windmill's geologist Earl T. Apfel, of Syracuse University, also served part time with the USGS. Apfel, operating from *Burton Island*, collected and returned nearly 3 tons of rock and mineral specimens from locales along the continent's eastern and western coasts. During the same austral summer, a civilian expedition, led by Captain Finn Ronne, of the U.S. Naval Reserve (USNR) and under contract to the ONR's Geophysics Branch, continued its second year of operations from his *City of Beaumont* in Marguerite Bay on the Antarctic Peninsula.[142] In June 1947, Ronne proposed a 10-year program for U.S. mapping and claims, hoping its results would assist an international settlement of all national claims in Antarctica. Ronne's 1946–48 expedition mapped by air nearly 1.2 million square miles, 50 percent of which was seen for the first time, and claimed some 250,000 square miles. As part of the expedition's scientific work, Robert L. Nichols, a Tufts professor who worked part time with the USGS, studied the geology and geomorphology of the area around Marguerite Bay.

Hydrologist Carl Gustave Paulsen (1887–1961), who joined the USGS in 1913, served as Chief of the Surface Water Division (1931–39) and then Assistant Chief Hydraulic Engineer (1939–46). On March 1, 1946, Paulsen succeeded Chief Hydraulic Engineer Glenn Parker, who had died suddenly on February 12. Paulsen made the Divisions of the Water Resources Branch work more harmoniously and effectively. He led the initial postwar reorganization of the Branch, during which a new generation of Division Chiefs took office. Paulsen retired in 1957 and then served part time as the Delaware River Master. (USGS photograph, Public Inquiries Office 50–13 [1a]; published in Ferguson and others, 1990, frontispiece.)

With the reorganizations of the Geologic and Topographic Branches well underway in 1945–46, Wrather and Nolan turned their attention to improving the administration and work of the Water Resources Branch. There, they faced two principal problems—the proliferation of local offices and a lack of harmony between two of its four main units. In 1928, only 2 years after Congress limited the Topographic Branch's expenditures on its cooperative projects with the States and municipalities to 50 percent of the total of the funds spent by the USGS and the States and municipalities for this work and specified the Branch's dollar amount, the legislators also applied the same restrictions to the Water Resources Branch's appropriation. The funding model required the Water Resources Branch to continue its liaison offices in each State, and suboffices in the larger States, "many situated in localities where they could not be advantageously used by the other divisions [branches]," but the growing demand for groundwater studies required establishing even more of these local offices. Wrather also found that the surface-water and groundwater units "were not working together harmoniously." Philosophical and personal disputes between Chief Hydraulic Engineer Glenn Parker and Oscar Meinzer, Chief of the Ground Water Division, enhanced the units' differences in method, equipment, and personnel. Parker favored providing water data without interpretations; Meinzer, whose own investigations and those of his staff combined geology and engineering, promoted such assessments and encouraged their publication. Nathan Grover, the former Chief Hydraulic Engineer recalled to service with the Branch in 1942, agreed with Wrather's analysis of the problem "in all essential details."[143] The Director's meeting with Parker and Meinzer failed to improve the situation. Wrather planned to make a change after the appropriations hearings in the spring of 1946, but Parker died suddenly on February 12.

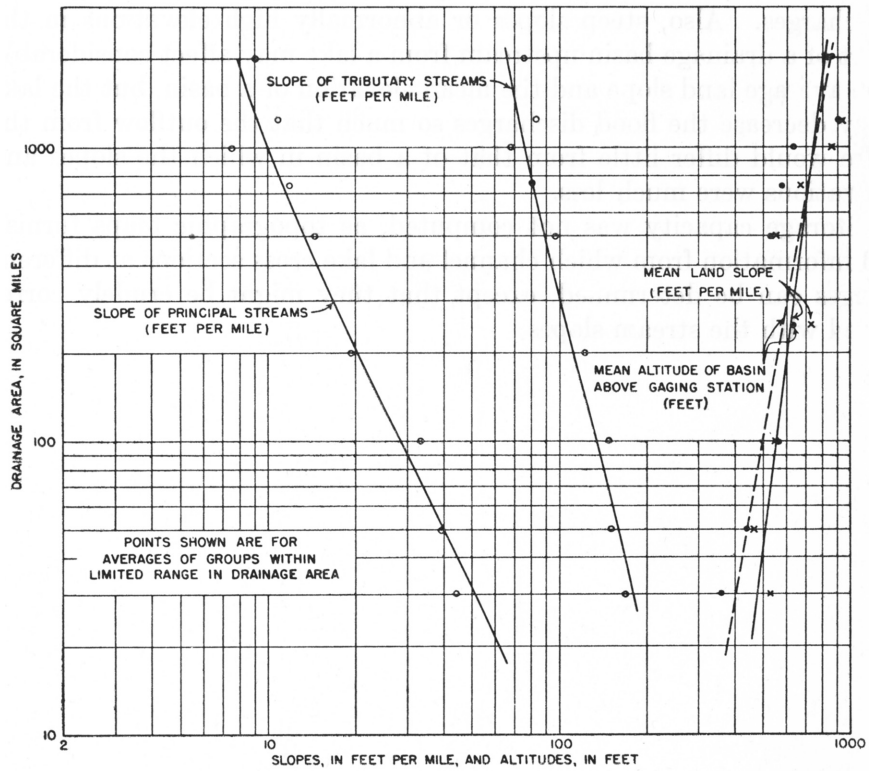
Hydrologist Albert Nelson Sayre (1901–67) joined the USGS Ground Water Division in 1929. Wartime service with the USGS Military Geology Unit and other civilian organizations took him to El Salvador, the Pacific, and a landing with Army units on Leyte in the Philippines. Late in 1945, Sayre began supervising all Ground Water Division operations west of the Mississippi River. Sayre succeeded Oscar Meinzer as Chief of the Division in December 1946, and continued his predecessor's emphasis on scientific geohydrology as the Division tripled its staff size. Sayre retired in 1959 to return to research. (Photograph from McGuinness, 1970.)

Carl Paulsen, Parker's deputy and Acting Chief of the Surface Water Division after Rudolph Kasel died in June 1945, took over as Chief Hydraulic Engineer on March 1, 1946. Paulsen worked to improve Branch cooperation with other Federal agencies and the States. "He and Meinzer got along well together, which paved the way for greatly improved relations between the services." Wrather, Nolan, and Paulsen arranged for "a series of regional conferences,"[144] in which Wrather or Nolan participated, to promote better understanding and cooperation between two of the four divisions. Paulsen strove to make all of the Branch's units work as one. On July 22, Paulsen received responsibility for all water-resources investigations conducted in Alaska. The Water Resources Branch's transition from war to peace proved less abrupt. Months before the war ended, a large number of requests arrived for investigations of the availability and chemical quality of water for civilian needs in connection with flood control, industrial installations, inland navigation, irrigation, municipal supplies, and power production. Greatly increased use of water during wartime, population shifts following the establishment of new industries in areas previously rural or thinly settled, expansion of existing industries, and the need for increased power, as well as larger production of agricultural commodities, offered the Branch a multitude of new challenges and responsibilities.

Replacing retirees during the fall of 1946 brought forward a new generation of Division managers in the Water Resources Branch, like those in the Geologic and Topographic Branches, largely by promotion from within the ranks. On September 17, Paulsen passed the leadership of the Surface Water Division to Joseph V.B. Wells, the District Engineer in Louisville, Kentucky, since February 1940. William Collins retired at the end of September 1946, and S. Kenneth Love, who supervised field studies in several States, succeeded Collins as Chief of the Quality of Water Division on October 1. Adrian H. Williams, recently transferred from work in Montana, became Love's principal assistant. Meinzer, now 70 and the "Nestor" of groundwater hydrology, retired at the end of November. Nelson Sayre, then supervising these studies in the States west of the Mississippi, replaced Meinzer as Chief of the Ground Water Division on December 1. Royal Davenport continued to lead the Division of Water Utilization, which absorbed the duties and responsibilities of the Division of Power Resources after Albert Horton died in April 1945.

Wrather and Paulsen's additional administrative changes also affected coordination, planning, and control within Interior and the Director's Office, as well as the Water Resources Branch. Krug's Secretarial order of September 26, 1946, established a Pacific Northwest Coordination Committee,[145] composed of representatives from the USGS, the Bonneville Power Administration, and six other agencies, including Interior's new Bureau of Land Management (BLM).[146] On July 16, the 79th Congress and President Truman founded the BLM by consolidating the functions, funds, and staffs of the General Land Office, the Grazing Service, the Oregon and California Railroad Revested Lands Administration, the Alaska Fire Control Service, and other units, as recommended by Secretary Ickes in January and now part of Reorganization Plan No. 3. On November 13, Wrather and Paulsen made Arthur Piper, then at Portland, a new Staff Scientist in the Director's Office and the "adviser and consultant to the Director on Survey affairs in the Pacific Northwest and coordinator of Survey activities in that region."[147] Paulsen also confirmed Parker's decision, just before he died, to detail George E. Ferguson, Florida's District Engineer since 1940, to the Chief Hydraulic Engineer's staff in Washington, where Ferguson began planning a reorganization of the office's staff aimed at improving the administration of the Branch's expanding programs.

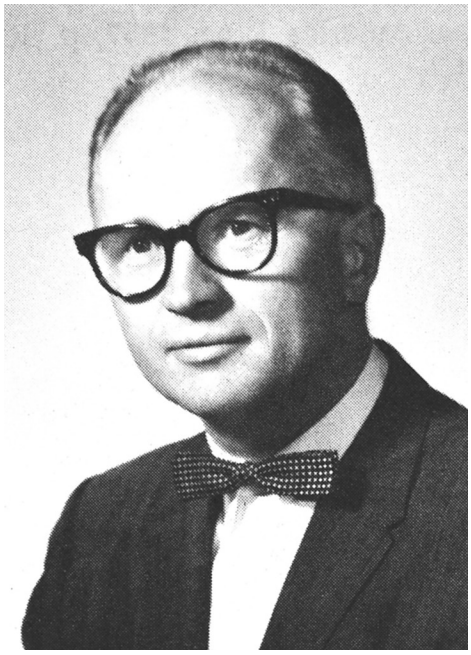
For fiscal year 1946–47, the Water Resources Branch managed slightly more than $6,366,000 in total funds, an increase of about 19 percent over the preceding year, for salaries of and operations by its staff of 1,040 full-time and 2,500 part-time employees, a significant rise from the total of 765 people employed at the end



This graph shows the "general variation in stream slopes and altitude in relation to size of drainage basin." Walter Langbein and his USGS colleagues measured 240,000 miles of streams and counted about a million contours shown on 1:62,500 topographic maps that depicted 145,000 square miles in 340 drainage basins in the northeastern United States. They also counted about 1 million contours and translated them into land and channel slopes. "The divergent trends of the lines showing the principal channel slope and average land slope" indicated that the slope ratio of the basins analyzed tended "to decrease with increase in drainage area." Their study was part of USGS efforts to segregate and evaluate the causative factors in river floods. The results indicated that "none of the topographic factors [in these basins] are unique, but each reflects a condition that also influences the others." (Quotations and graph from Langbein and others, 1947, p. 143 and 125 and fig. 52.)

of fiscal 1943–44. Of the new sum, Congress appropriated nearly $2,589,000, or 41 percent, directly to the USGS; the States and municipalities contributed about $1,936,000, or 30 percent, for cooperative investigations; and some $1,841,000, or 29 percent, came from other Federal agencies. During the year, Branch personnel worked out of more than 100 field offices, one or more of which was located in nearly every State and in the Territory of Hawaii. Members of the Surface Water, Ground Water, and Quality of Water Divisions participated in the Missouri River Basin program, drawing on the $804,000 transferred by the Bureau of Reclamation. Secretary Krug's order of May 31, 1946, established a Missouri Basin Field Committee,[148] led by Glenn Sloan, coauthor of the Pick-Sloan plan for the Basin, and including representatives from the USGS and six other Interior Department agencies. Interior's Water Resources Committee supervised the Field Committee, which represented the Department on the Missouri Basin Inter-Agency Committee that the Federal Inter-Agency River Basin Committee established on March 29, 1945. The Missouri Basin Inter-Agency Committee included representatives of the Agriculture, Interior, and War Departments and the Federal Power Commission (FPC) and the Governors of Missouri, Montana, Nebraska, and Wyoming. In the Missouri Basin, members of the Water Resources Branch collaborated in installing 55 new gaging stations, expanding studies to cover areas in 24 localities with problems related to groundwater or to changes in groundwater conditions arising from reservoir construction or irrigation, measuring the sediment content of surface waters at 44 regular and 7 special stations, and testing the chemical quality of water at 13 regular and 63 other stations.

Members of the Water Resources Branch's units also continued their regular activities. By the end of the fiscal year, the Surface Water Division operated nearly 5,220 gaging stations; some 230 of them in cooperation with other Federal, State, county, and municipal agencies. Division personnel established seven initial gaging stations in Alaska and planned a gradual expansion of the Territory's fledgling system. Members of the Division installed a two-way radio station at the gaging station on the Colorado River at Lees Ferry, Arizona, to make information about river



Hydrologist Charles Edward Jacob (1914–70) earned an M.Sc. in Civil Engineering (Hydraulics) from Columbia University in 1936 and then joined the USGS. In studies on New York's Long Island and in Texas and Florida, he used differential equations and other mathematical techniques in analyzing the permeability, storage transmissibility, and drawdown of groundwater, especially from elastic ("leaky") aquifers. Jacob led the Water Resources Branch's Section of Ground Water Hydraulics before resigning in 1947 to enter academia. In 1961, he founded C.E. Jacob & Associates as an international consulting firm. (Photograph from Titus, 1973.)

flow available promptly for use in administering the Colorado River Compact and for operating Federal projects such as Hoover Dam. They also began a program, in cooperation with the Public Roads Administration and several State highway departments, to work out better procedures for obtaining and utilizing streamflow records in solving hydraulic and hydrologic problems connected with highway structures. Interstate compacts for the allocation among the States of the waters of interstate streams required the Division to establish and operate gaging stations on the Colorado, Belle Fourche, and Republican Rivers, the Rio Grande, and Costilla Creek, as negotiations continued for similar agreements for the Arkansas and Bear Rivers. Division personnel also continued investigations for the allocation and control of waters along the U.S.-Canadian boundary and made special studies for the International Joint Commission, particularly those relating to the Columbia River Basin and Sage Creek in Montana. They also continued work along the U.S.-Mexican boundary, as required by 1944's water treaty between the two Republics.

Members of the Ground Water and Quality of Water Divisions participated in investigations in some 350 projects scattered through nearly every State, Hawaii, and Puerto Rico. They prepared nearly 200 formal reports and answered several thousand requests for information on groundwater conditions in all parts of the country. By the end of 1946, Charles Jacob published a method for analyzing data on interference from the pumping of several wells, developed a physical basis for Theis' 1935 equation, defined the storage coefficient, and analyzed radial flow in an elastic, or "leaky," artesian aquifer.[149] Jacob resigned to lead the Department of Geophysics at the University of Utah in 1947, the year he published the details of his drawdown test to determine the effective radius of artesian wells.[150] The Quality of Water Division established two new field laboratories—one at Salt Lake City to serve as a regional laboratory for both Federal and State interests in a large area of the West and the other at Philadelphia to handle a portion of the State cooperative program in Pennsylvania. The Division's laboratory staff analyzed the chemical quality of more than 11,000 water samples, continued its program for measuring sediment in streams, and operated facilities for analyzing sediment at Philadelphia and Albuquerque, and at Dickinson in North Dakota, Lincoln in Nebraska, Norton in Kansas, and Worland in Wyoming.

At war's end, the four Divisions of Harold Duncan's understaffed Conservation Branch continued to be fully occupied by their regular activities. The increase in the Branch's work during the war did not end with the advent of peace. In the fall of 1945, Harold G. Barton replaced Duncan as Chief of the Branch's Oil and Gas Leasing Division at the time its work increased yet again. The production of minerals from public and Indian lands continued at wartime rates, but the output of oil and gas actually increased to meet industrial and civil needs during the Nation's return to a peacetime economy. Director Wrather convinced Secretary Krug not to transfer the Conservation Branch to the USBM or the BLM, as sought by the directors of those agencies. Wrather argued that doing so would require congressional modification of "the [scientific] classification of the public lands"[151] mission in the legislation that established the USGS in 1879. The Conservation Branch's work on the unitization of oil and gas fields, Wrather added, also was so integrated with its land-classification and mineral-leasing responsibilities "that they could not be easily disentangled. The enforcement of the conservation laws had been tactfully handled," he believed, "and amicable relations existed with the oil producers." As "practically the entire force * * * had been raised in the Survey," Wrather concluded, they "did not wish to leave it."[152] At the end of fiscal year 1945–46, that force numbered 220 full-time and 5 part-time employees, a net increase of only 15 since the end of fiscal 1944–45. The Conservation Branch received about $1,076,000 from all sources in fiscal 1946–47.

On July 22, 1946, the Conservation Branch also received responsibility for all land-classification activities conducted in Alaska.[153] Although hampered by an abnormal turnover of personnel, John Northrop's Mineral Classification Division accelerated its work pace and disposed of nearly 14,300 public-land cases during fiscal year 1946–47, a 16-percent increase over 1945–46; however, the number of cases it received grew by 53 percent. For agencies concerned with disposing of acquired Federal lands, the Division's staff determined the potentialities for fissionable materials of some 2,330 parcels, a 240-percent increase, in practically every State, Territory, and U.S. possession, as required by the Executive order[154] of March 4 and the Secretarial order[155] of April 19, 1946. The Division also established a new field headquarters in New Mexico. As fiscal 1946–47 progressed, Benjamin Jones' Water and Power Division and other Branch units expanded their work in the Missouri River Basin to meet the needs of the Army Engineers and the Bureau of Reclamation. On June 10, 1947, Acting Secretary Chapman, whose activities in formulating policy increased as Krug's interest waned, authorized Director Wrather, without prior approval, "to classify public domain lands as power sites valuable for power purposes and to modify or revoke such classifications."[156] Members of Barton's Oil and Gas Leasing Division supervised nearly 10,900 oil and gas properties, a 20-percent increase, on the public lands in 22 States and Alaska; more than 5,660 leaseholds on Indian lands, a 13-percent increase; the Rio Vista gas field for the War Department; and the 21 properties under lease in Naval Petroleum Reserve No. 2 in California, where production yielded nearly $895,000 in royalties, a 19-percent increase. Personnel in Howard Smith's Mining Division supervised mineral production whose value totaled nearly $73,744,000, a 10-percent increase, from which the U.S. Treasury, the Reclamation Fund, the Indian beneficiaries, and the States received more than $2,439,000 in royalties.

While Wrather dealt with internal and external challenges, the debate within the U.S. Government about taking a hard line versus a soft line toward the Soviet Union came to an end. Hardliners James Byrnes, James Forrestal, Averell Harriman, and Admiral William Leahy, joined later by Dean Acheson and General Dwight Eisenhower, Army Chief of Staff since November 1945, prevailed in the fall of 1946 over General Lucius D. Clay (Sr.), George Marshall, Robert Patterson, Henry Stimson, and Henry Wallace, who recommended a gentler approach. Late in March 1945, Roosevelt decided that Harriman, the U.S. Ambassador in Moscow since 1943, was right in thinking that Stalin had broken every promise he made at Yalta, yet the President still hoped for American-Soviet cooperation in the U.N. and elsewhere in the postwar world.[157] By early in 1946, Truman's own experiences as President led him to agree that the United States could not trust the Soviet Union. The Council of Foreign Ministers, convening again in Paris, agreed on terms on July 4 and called a meeting of representatives from 21 nations to consider drafts of the treaties for Axis satellite nations. Commerce Secretary Wallace remained an outspoken advocate of continued cooperation and trade with, and loans to, the Soviet Union. Truman dismissed Wallace on September 20, just 2 days after ordering him to end his foreign-policy comments. As Wallace's successor, Truman appointed Harriman; after leaving Moscow late in January, Harriman represented the United States in London before beginning to serve as Secretary of Commerce on October 7. Acheson, as Acting Secretary of State, announced on October 1 that the United States would keep its occupation forces in Korea south of the 38th parallel until Soviet troops evacuated the northern half of the peninsula and the Allied Powers formed a free government for the unified country. Shortly thereafter, the peace conference at Paris broke up after agreeing only on minor issues.

At home, President Truman continued to try after 1945 to secure a single Federal agency to support scientific research and education, but, as Merton England recorded, Truman wanted it in a form that he could fully accept. In January 1946,

Isaiah Bowman and Vannevar Bush discussed with Senators Kilgore, Magnuson, and Elbert Thomas how they might best modify the legislation to ensure approval by Congress and the President. On February 21, Kilgore and Magnuson, joined by Fulbright, Thomas, and other Senate colleagues, introduced a bipartisan compromise bill to establish a National Science Foundation. The measure called for an advisory National Science Board (NSB) appointed by the President, who also would appoint an Administrator after considering candidates recommended the NSB.[158] The Administrator would be required to consult the NSB on issues of budget, policy, and program. The NSB also would make recommendations to the President and Congress independent of the Administrator and approve all appointments to the Divisional Scientific Committees, whose chairs also would serve on the NSB. Although the compromise bill included some items not wanted by Bowman's Committee Supporting the Bush Report, its members recommended that the Senate's Committee on Military Affairs favor the bill and, when it did so, asked the whole Congress to enact it. The AAAS Council also voted overwhelmingly to support the Kilgore-Magnuson bill and appointed a special committee, chaired by James Conant, and including biophysicist Detlev W. Bronk (Director of the University of Pennsylvania's Johnson Foundation for Medical Physics), Ernest Lawrence, and geologist Howard A. Meyerhoff (the AAAS' Executive Secretary), to aid its passage. Conant drafted and sent a letter of support to all the Senators other than the bill's sponsors.

Delayed by debates about the extensions of the Selective Service Act of 1940 and the Office of Price Administration and the proposed atomic energy agency, the Kilgore-Magnuson bill passed the Senate on July 3, 1946, and went to the House's Subcommittee on Public Health, of the Committee on Interstate and Foreign Commerce. Meanwhile, Representative Mills revised and reintroduced his bill in the subcommittee on May 15 and held hearings during May 28–29, at which Bowman, Bronk, Bush, Edward U. Condon, Jewett, Secretary Patterson, and others testified. On July 16, the subcommittee reported out Mills' second bill, 2 weeks after the Secretaries of War and the Navy established a Joint Research and Development Board (JRDB). Bush chaired the new JRDB, also composed of two members each from the Army and Navy. Lloyd V. Berkner, an electrical engineer and Bush protégé who led the Navy Board of Aeronautics radar and electronics-materiel groups during 1941–45, served as the JRDB's Executive Secretary. The JRDB's committees included one for Geophysical Sciences and another for Geophysical Exploration, the latter chaired by Sidney Paige. On July 19, the Mills bill reached the Committee on Interstate and Foreign Commerce. Its members promptly tabled the measure when they decided they lacked the background and the information to defend their rejection of the Kilgore-Magnuson compromise in favor of Mills' revived bill. Meyerhoff, in announcing the legislative "homicide"[159] in an "obituary" in *Science* on August 2, the last day of the 79th Congress, placed the blame for the demise squarely on Bush and his supporters for the "political blunder which has cost science at least a year of life for the National Science Foundation." Meyerhoff decided that "The moral of 19 July is simple":

> **Only in a reasonable show of unity, achieved by some compromise, can scientists expect political results.[160]**

Although Truman continued to admire many of the prescriptions for a national foundation in "Science—The Endless Frontier" and the bills derived from it, he decided that Vannevar Bush's biases, and his influence on the legislative process in 1945–46, made imperative another Executive-sponsored report on this issue.[161] The President tried to have the second report ready for evaluation and legislative action during the 80th Congress. On October 17, 1946, Truman issued an Executive order that required economist John R. Steelman, former Director of

War Mobilization and Reconversion and now the President's special assistant for labor issues, to review current and proposed scientific research and development conducted or financed by the Federal Government. To assist Steelman, Truman issued an Executive order on October 17 that established an interdepartmental President's Scientific Research Board[162] (PSRB) to begin operating in November and named Steelman as its Chairman. The new PSRB's 15 members included the Secretaries of Agriculture, Commerce, Interior, Navy, and War; the Administrators of Federal Loans, Federal Security, and Federal Works; the OSRD's Director; the Chairmen of the AEC, the Federal Communications Commission, the NACA, and the TVA; the head of the Veterans Administration; and the Secretary of the Smithsonian. J. Donald Kingsley, former Deputy Director of War Mobilization and now program coordinator at the White House, acted as the Board's Executive Secretary. Chemist Lyman Chalkley, a veteran of the Office of Production Management (OPM) and the Board of Economic Warfare (BEW), and Bush's assistant in the OSRD since 1943, served as the PSRB's Scientific Advisor. Each of the Board's members designated one full-time person from his staff or agency as an alternate. On December 26, 1946, USGS Assistant Director Thomas Nolan began serving as Krug's representative on the PSRB's Board of Alternates, with Edward Condon and Carroll Wilson.

In establishing the PSRB, Truman emphasized that

> **[n]ational security and the development of the domestic economy depend upon the extension of fundamental scientific knowledge and the application of basic principles to the development of new techniques and processes. The Nation has a vast reservoir of war-accelerated technological development which must be applied speedily and effectively to the problems of peace—stepping up productivity in both industry and agriculture, creation of new farm and factory products and advancement of medical science. Fundamental research, necessarily neglected during the war, must be resumed if scientific progress is to continue.[163]**

Truman directed the PSRB to investigate and report on "the current and proposed scientific research and development activities conducted or financed"[164] by the Federal Government, including their content and balance, their administration and costs, the type and number of scientists employed and the conditions under which they worked, policies in respect to research contracts, national scientific resources in terms of people, money, and facilities, and the training of scientific personnel. In particular, Truman requested a careful inquiry into the current shortage of scientists. The Federal Government, he stipulated, would continue to play an important role in all areas of research, but the share of the national income that could be devoted to research had definite limits. The President's order laid the groundwork for a general plan designed to ensure that Federal scientific research would "promote the most effective allocation of research resources between the universities, the research foundations, industry, and the Federal Government" so that they might be "used most effectively in the national interest." "There must be no duplication, overlapping or inefficiency," Truman stressed, "to hamper Federal research. In view of the current level of Federal expenditures, our research activities must be conducted with minimum expenditures consistent with the essential objective of a Federal program."[165]

As Truman founded his President's Scientific Research Board, campaigns continued for the midterm elections. Republican candidates for the 80th Congress used "Had enough?" as an effective weapon against the President. On November 5, the Grand Old Party won enough races to control both chambers for the first time in 16 years.[166] As Samuel Rayburn's successor as Speaker of the House, Republicans elected Joseph W. Martin, Jr., a conservative from Massachusetts, a former minority leader, and another skillful political technician. Maine's Wallace H. White,

Jr., led the Republican majority in the Senate, but he did so in name only. Senators Arthur Vandenberg and Robert Taft, both, like Martin, opposed to the New and Fair Deals, shared the real responsibilities for party leadership. Vandenberg, who replaced Tennessee's Kenneth McKellar as President of the Senate pro tempore, handled foreign affairs, while Taft dealt with domestic issues.

Truman presented his State of the Union Message to the new Congress and to television cameras on January 6, 1947. He advocated a balanced budget, a streamlined military establishment, and international control of atomic energy.[167] Truman also called for improvements in labor-management relations, strengthened antitrust laws, national health insurance, "a fair income"[168] for farmers, aid to veterans, an aggressive program for constructing homes, and new progress in civil rights. On the following day, Truman announced the resignation of Secretary of State Byrnes and the appointment of General Marshall to succeed him. Marshall named George Kennan to lead a new Policy Planning Staff on May 7.

On January 21, 1947, hearings began in the 80th Congress on the bill providing Interior with appropriations for fiscal year 1947–48. The measure proposed an appropriation of $295 million for the Department and nearly $18,105,000 for the USGS in fiscal 1947–48, the latter sum almost double the direct appropriation received for fiscal 1946–47. Secretary Krug, making his initial appearance before the House subcommittee, assured the Representatives that a committee was examining his Department's programs to determine priorities and bureaus' programs to ensure they contained no conflicts of interest or duplication of effort. The total amount Krug requested caused consternation among some of the legislators. Ohio's Robert F. Jones, Jed Johnson's successor as the subcommittee's chairman, and Benton Jensen welcomed Ivor D. Fenton (R–PA) and Lowell Stockman (R–OR). Democrats Michael Kirwan and William Norrell were joined by Albert A. Gore (Sr., D–TN). Jones quickly observed with amazement that in 1938 and 1939 Interior's appropriations were, respectively, only $132.7 million and $129.7 million. Now, Jones continued, the Bureau of Reclamation alone asked for $145.7 million! Ohio's irrepressible Kirwan, now the ranking minority member on the subcommittee, seemed less alarmed by the larger numbers. On February 3, when Wrather and his principal managers arrived to discuss the USGS budget request, Kirwan declared that he could not understand why they came with a request for so small a sum. In 1938, Secretary Ickes requested an amount for the agency that equaled about 1.3 percent of the DoI's budget. Now the USGS asked for only 0.87 percent of Interior's budget. Kirwan wondered why the agency was not keeping up with the rest of the Department.

In April, Interior's managers also submitted a draft for a bill to provide permanent substantive legislation to support USGS activities that were authorized each year in the annual appropriations bills, because items in the appropriations act must conform to the language of the USGS establishing legislation or they would be subject to point-of-order objections. This effort derived from proposals, reported in January by Krug's coordination committee, to examine the bureaus' contemplated programs, try to eliminate conflict and (or) duplication, determine emphasis and priority, and provide the greatest degree of mutual support. It also reflected the ongoing congressional debate about establishing a national foundation for science and the proposal in May 1946 by Senator Carl Vinson (D–GA), past Chairman of the Committee on Naval Affairs, that led to the founding on August 1 of the Office of Naval Research.[169] The ONR and its civilian Advisory Committee were intended "to plan, foster, and encourage scientific research"[170] to maintain the Nation's naval power and preserve its security. Harold Bowen, now a Vice Admiral and the Navy's Chief of Research and Inventions, became the ONR's Chief and so served until November 1. Bowen's Army equivalent was the Director of Research and Development, a new General Staff (G–6) slot. Physicist Alan T. Waterman,

long on loan from Yale to the NDRC and then to OSRD's Office of Field Service, began serving as the ONR's Deputy Chief and Chief Scientist. The ONR's Advisory Committee included Bronk, Arthur and Karl Compton, DuBridge, and six other members.

Interior's draft bill for appropriations in fiscal year 1947–48 contained six sections about the USGS. The initial part of section 1 reproduced the USGS original block-funded legislation, enacted on March 3, 1879, except for setting the Director's salary at $10,000 to gain congressional authorization to classify the position as a Professional and Scientific grade 9 (P&S–9 or P–9). The second part of section 1 made clear the reenactment would not repeal or qualify laws since enacted regarding classification of the public domain or investigations of mineral resources. Section 2 of the draft made specific provision for topographic surveys, chemical and physical research, and water-resources investigations. Section 3 provided permanent substantive support for the transfer of funds from other Federal agencies. Section 4 furnished support for cooperative investigations with State and local government agencies, as authorized in the legislation enacted in the 1920s, and proposed cooperation with the Carnegie Institution of Washington, the Smithsonian Institution, and other nonprofit organizations. Section 5 provided for publication and library exchange. Section 6 supplied authorization for contracting some phases of the work. No section, however, addressed the problem of statutory authorization for USGS work outside the national domain to end its dependence on detailing agency personnel to other departments. The Committee on Appropriations reported the bill favorably, but the House took no further action on the measure.

The total funds requested by Interior for the USGS for fiscal year 1947–48 included $8.5 million for topographic surveys, $3,135,000 for geologic surveys, $250,000 for mineral-resources work in Alaska, $3.75 million for water-resources investigations, $350,000 for classifying lands, $748,000 for supervising mineral leasing, and $150,000 for printing and binding. Wrather hoped "to complete the detailed geologic mapping of the United States within the next 30 years," but he reported that it was "only 10 percent mapped at the present time."[171] The estimate for USGS topographic surveys in fiscal 1947–48, nearly three times the current appropriation, would fund the initial step in the third 20-year program proposed by the USGS since the 1880s to complete, after Director Powell's failure by 1894 and Congress' unwillingness to fund the Temple Act of 1925, the larger scale mapping of the United States. Gerald FitzGerald believed the sum represented only one-fiftieth of what would be needed overall. The War Department's recognition of the USGS as the prime domestic mapmaking agency and its proposal to appropriate to the agency the funds for strategic mapping explained part of the increase over the fiscal 1946–47 monies. Would sums be saved by restricting topographic mapping to areas requested by the War Department? FitzGerald pointed out that what the War Department wanted for fiscal 1947–48 alone would cost $48 million, a request already scaled down. For USGS geologic surveys, the Bureau of the Budget approved $3,135,000, nearly 1.6 times the amount appropriated for fiscal 1946–47. House subcommittee members asked if more results could be obtained for the money provided by concentrating geologic surveys on smaller areas rather than all over the country. Chief Geologist Bradley reminded the legislators that nature spread mineral resources countrywide, which meant his program must be planned and executed nationally. Pressed to state which of the requested increases in funding—for metals, fuels, or other studies—was the most important, Bradley declined; they were all the top priorities of a long list. When Chairman Jones inquired if "Your song is 'All or nothing at all'?"[172] (the title of Jack Lawrence and Arthur Altman's 1940 hit), Bradley wasted no words in replying "Yes."[173] In response to the USGS request for a sum about 1.5 times the original appropriation for water-resources studies in fiscal 1946–47, the legislators asked if some reimbursement

plan could be worked out whereby the agency could charge private industry for benefits received, but it could not be done.

The House Committee on Appropriations reported out its version of Interior's appropriations bill on April 21. The Representatives set Interior's funding at $156.5 million, or about 53 percent of the requested amount, and recommended that the USGS be given some $9,113,000, or 50 percent of the budget request. Within those totals, however, the House proposal contained uneven cuts. The committee reduced the recommendation for topographic surveys to just $3 million, an amount equal to the 1946–47 appropriation, and that for geologic surveys to $1,690,000, or $310,000 less than the total in 1946–47. The legislators suggested $2,578,680 for water-resources studies, a sum only a little less than the amount approved for the previous year, but then they added a proviso that none of these funds could be used for groundwater investigations. They also cut monies requested for land classification and mineral-lease supervision, respectively, by 49 and 31 percent. Some of the members of the committee explained these reductions by reminding the USGS that the war ended nearly 2 years earlier. Despite this fact, they continued, the committee encountered stubborn and continued resistance in trying to reduce the appropriations for the agency. Although the amount recommended in the bill remained very substantially in excess of prewar appropriations for the USGS, these members of the committee felt that they had made a step in the right direction in trying to limit funds for the agency to what they termed a normal peacetime level.

The Interior Department made no attempt to hide its dismay over the committee's report, which again provoked subcommittee chairman Robert Jones. He complained that Secretary Krug's condemnation of the bill reminded him of a singer, in what he termed Truman's anti-inflation production, stepping up to the footlights and warbling "for all, or nothing at all," while the chorus of New Deal spenders tiptoed and kicked their way across the stage. Jones' expansion of his earlier exchange with Bradley during the hearings evoked an image worthy of a USGS Pick and Hammer Club show, but the discussion in the House made it clear that Jones' view did not represent the sentiments of all members of his subcommittee. Jones charged that only four of the seven members of the subcommittee tried to hold the line against the inflationary movement in Interior, whereupon John J. Rooney (D–NY) retorted that the majority was trying to wreck the Interior Department. Kirwan and Gore also disassociated themselves from the committee's action. Clair Engle (D–CA), a lawyer and reclamation enthusiast sometimes known as "Congressman Fireball" for his colorful and outspoken speech, observed that all of his colleagues realized that the strictest economy should be practiced in Government operations. But care should be exercised, Engle continued, to ensure that the committee insisted on true rather than false economy. The Government, he emphasized, wasted large sums during the war to obtain information in a desperate hurry because earlier investigations by its agencies proved insufficiently extensive. We should not, Engle warned, allow that situation to occur again. The House nonetheless voted for the appropriations recommended by its subcommittee.

Secretary Krug appealed to the Senate subcommittee, now chaired by J. Chandler ("Chan") Gurney (R–SD), to restore the House's cuts in the Interior Department's budget. Gurney's fellow Republicans on the subcommittee included holdover Guy Cordon and two newcomers—Idaho's former Representative Henry C. Dworshak, newly elected to fill a death vacancy, and William F. Knowland of California. Democrat Carl Hayden was now the subcommittee's ranking minority member.

Krug told Gurney's subcommittee that the House's action would "require abandonment of some essential services which have been rendered by the Survey for as long as a half a century, and the cessation of a large volume of work, some of it already in part completed, which is of vital importance not only to industry

but to the security of the country." Public-land classification and mineral-leasing supervision were "functions which the Survey has been performing for many years by specific mandate of Congress."[174] Royalties from these activities increased from about $9.5 million in 1938 to the more than $14 million estimated to accrue in 1947. The savings of $200,000 in appropriations for these purposes would result in a reduction of about $1.1 million, or 10 percent, of the approximately $11 million in revenues from the public lands that went to the reclamation fund, State school funds, and the Federal treasury. Krug also pointed out that the U.S. Government, in planning irrigation and water-control projects, continued to be one of the chief beneficiaries of the USGS groundwater surveys that the House thought should be made by States, counties, and municipalities. The work should be done, he added, by a Federal agency, as "underground pools and streams are no more respecters of political boundaries than are surface lakes, pools, and streams." The cuts, Krug continued, would diminish the value of the surface-water investigations that needed to be continued because the results would lack data from groundwater studies. Reductions in the appropriation for geologic surveys would require abandoning some 30 projects, would result in the loss of the $750,000 already invested in them, and might "delay for years any progress toward the discovery of new reserves of badly needed minerals." As for topographic mapping, the Secretary said the USGS speeded up its mapping program at the request of the War Department, which remained anxious to have the program completed in 20 years. "Under the leisurely program provided by the House," Krug predicted, "we shall be lucky to have this work performed by the year 2020."[175]

Senator Milton R. Young (R–ND) was one of the witnesses who encouraged the Senate subcommittee to support the USGS budget, especially the funds for its water-resources program. Young attested that Lee Rogers, president of Lane-Western in Minneapolis, carried a lot of weight in the House, but Young thought that Rogers' company remained in disrepute in North Dakota. Nathan T. Veatch, president-elect of the American Water Works Association, Donald O. McBride, Secretary and Manager of the National Reclamation Association, and Rogers himself also appeared before the legislators, who added letters from State Geologists and other officials. The Senators voted to restore the full amounts for USGS geologic and topographic surveys and voted for increases of $106,000 for classifying the public lands, $215,790 for supervising mineral leases, $46,320 for water-resources investigations, and $90,500 for publications. They also suggested that the House's proviso that no funds for streamgaging be used for groundwater studies be changed to the more innocuous requirement of the preceding year that these funds could not be used to drill wells to supply water for domestic use.

In approving USGS appropriations for fiscal year 1947–48, the House yielded to the Senate on the level of funding for streamgaging and determining the U.S. water supply, public-lands classification, and mineral-lease supervision. The two bodies agreed on $3 million for topographic surveys, $2.3 million for geologic surveys and $389,000 for printing, binding and related costs of publication; the last sum represented a $53,000 reduction from fiscal 1946–47. The final proviso about streamgaging funds also reflected a modified compromise—"no part of the funds appropriated * * * shall be used for the payment, directly or indirectly, for the drilling of water wells for the purpose of supplying water for domestic use"—but one to which the USGS did not object. Congress directly appropriated a total of more than $10,091,000 for USGS salaries and operations for fiscal 1947–48. The legislators also authorized the USGS to "acquire by transfer without exchange of funds, for two years beginning July 1, 1947, from the War Department, the Navy Department, or the War Assets Administration, equipment, materials, and supplies of all kinds, with an appraised value of not to exceed $500,000 from the surplus stores of these agencies."[176]

While Congress debated the level of funding for Interior and the USGS, the Nation's impasse with the Soviet Union remained unresolved. On December 26, 1946, the Soviet Union and Poland abstained from the general approval of an American plan for far-reaching nuclear control and inspection by the United Nations. On February 18, 1947, the Soviets proposed amendments opposing the degree of international control recommended in the report approved 2 months earlier. The Soviets vetoed subsequent attempts by the Security Council to agree on an atomic controls plan. Finally, on March 5, the Soviet Union rejected the United Nations Atomic Energy Commission's report. The Council of Foreign Ministers arranged, and Secretary Byrnes signed before resigning in January, peace treaties with Bulgaria, Finland, Hungary, Italy, and Romania that made territorial adjustments and provided reparations. By their provisions, the Soviet Union received Bessarabia, northern Bukovina, and Finland's Petsamo area and nickel mines, its Porkala, Rybachiy, and Karelian Peninsulas, and significant reparations. The ministers made no progress on permanent settlements with Austria and Germany. From March 10 to April 24, Secretary of State George Marshall and British Foreign Secretary Ernest Bevin met with Soviet officials in Moscow, but they could not agree on the type of government for Germany. The United States and Britain favored a federal form, but the Soviet Union preferred a more centralized arrangement. Britain and the United States refused the Soviet demand for $10 billion in reparations from Germany. The two powers noted with dismay that Soviet influence on or control over the governments of Eastern Europe continued to grow, as did Soviet interference in the internal affairs of Greece and Turkey, Iran, and other Middle Eastern countries. On February 21, 1947, the British Government officially informed the U.S. State Department that internal economic difficulties would force Britain, also looking forward to the end of its troubled U.N. mandate in Palestine since 1920, to suspend economic and military aid to Greece and Turkey as of March 31. In 1946, French troops had withdrawn from their mandates in Syria and Lebanon, and the British had remade the autonomous Transjordan of 1921, two-thirds of their Palestine mandate, as the independent Kingdom of Jordan.

President Truman, responding to these challenges, laid down the general lines of a policy for containing the Soviet Union in his special message to a joint session of the 80th Congress on March 12. Truman asserted that

> **it must be the policy of the United States to support free peoples who are resisting attempted subjugation by armed minorities or by outside pressures. I believe that we must assist free peoples to work out their own destinies in their own way. I believe that our help should be primarily through economic and financial aid which is essential to economic stability and orderly political processes.[177]**

The President did not mention the Soviet Union by name, but he followed his statement of principle by asking for $400 million in aid to Greece and Turkey, the two countries most immediately menaced by Soviet expansion. On April 16, Bernard Baruch claimed that America already was in a cold war.[178] The principle of flexible containment of Soviet expansion, formulated in part by George Marshall and published in "The Sources of Soviet Conduct" by "X" (George Kennan) in the July issue of *Foreign Affairs*, became known as the Truman Doctrine. Kennan again warned his readers that the Soviet Union, which naturally viewed containment as encirclement, remained confident that history was on its side. He continued to recommend a protracted policy of patient, staunch, and watchful containment of Soviet expansionism[179] but one without unnecessary histrionics, gestures, or threats. The Soviet system, Kennan asserted, likely would decay from within, and so containment came to include all counter-force measures short of war while waiting for the demise. On April 23, the Senate formally endorsed aid to Greece and Turkey,

to maintain "their national integrity and their survival as free nations,"[180] and the House agreed on May 9. Truman signed the aid bill into law on May 22.

International affairs, particularly those in Eastern Europe, continued to demand Truman's attention during the remainder of 1947. On June 5, the United States ratified peace treaties with Bulgaria, Finland, Hungary, Italy, and Romania. Twenty days later, a U.N. commission reported that Albania, Bulgaria, and Yugoslavia supported guerilla warfare in Greece. On July 29, the United States proposed a resolution to accept the commission's findings and implement its recommendations. Although the Soviets blocked approval by the Security Council, the General Assembly passed the measure on October 21 long after Secretary Marshall presented another American response. On the day official peace began with the five European countries, Marshall received an honorary degree from Harvard. In return, he assured the audience that U.S. policy was directed against chaos, desperation, hunger, and poverty, and not against nations or philosophies. U.S. policymakers hoped to revive a worldwide effective economy that would enable political and social circumstances to arise and support free institutions. Marshall declared that it would not be efficient or proper[181] for the U.S. Government unilaterally to draw up a program designed to put Europe on its feet economically and suggested instead a joint program, agreed to by most, if not all, European nations, recipients of more than $11 billion in U.S. aid since 1945. The United States also secured an international agreement promoting the growth of global trade by reducing tariff and other barriers when 23 countries signed in Geneva on October 30, 1947, the General Agreement on Tariffs and Trade (GATT) and promised to continue negotiations at future biennial meetings.

British Foreign Secretary Bevin and French Foreign Minister Georges Bidault met with Soviet Foreign Minister Molotov to discuss drawing up a European recovery plan along the lines suggested by Secretary Marshall. Molotov, on orders from Stalin, walked out and damned Marshall's plan as an imperialist plot to enslave Europe. Unfazed, representatives of 16 nations met in the Marshall Plan Conference at Paris during July 12–15, 1947. On September 22, they reported that Europe's needs during the next 4 years would require an additional $16 billion to $24 billion in aid. The Soviet Union and its European satellites refused to participate in the European Recovery Program and instead formed their own mutual-assistance system. Stalin ordered his Communist leaders throughout Europe to redouble their efforts to seize power before the Marshall Plan could begin its restorative work. He also directed Deputy Foreign Minister Andrei Y. Vyshinsky, the Soviet representative at the United Nations, to begin an offensive in that forum. In the U.N. General Assembly on September 18, Vyshinsky attacked Americans as warmongers. On October 5, Moscow announced the formation of the Communist Information Bureau (Cominform), to coordinate, from its Belgrade headquarters, the activities of the Communist parties of Bulgaria, Czechoslovakia, France, Hungary, Italy, Poland, Romania, the Soviet Union, and Yugoslavia. Stalin planned to use the Cominform as part of his efforts to block the Marshall Plan. On December 17, Truman responded by signing an act to "promote world peace and the general welfare, national interest, and foreign policy of the United States by providing aid," initially up to $150 million via the Reconstruction Finance Corporation (RFC), to Austria, China, France, and Italy "to alleviate conditions of hunger and cold and prevent serious economic retrogression."[182] One clause therein required that petroleum and petroleum supplies furnished to the recipient countries be obtained from sources outside the United States, "to the maximum extent practicable," and delivered "by the most economical route from the source of supply."[183]

In the Far East, the bitter struggle continued between Communists and Nationalists for the control of China, the fate of Korea remained undecided, Japan received a new constitution, and India and Pakistan won their independence as Dominions in the British Commonwealth. On January 29, 1947, the United States

ended its efforts at arbitration in China, and Marshall criticized both Chiang and Mao for failing to reach a lasting agreement. Nationalist successes in the north peaked in March, and during that month Nationalists also captured Yan'an, the Communists' capital since the end of their "Long March" to Shaanxi Province. General Albert C. Wedemeyer knew conditions in China, from long service there, better than most persons in the Truman administration, but Wedemeyer's mission in July and August fared no better than Marshall's. In reporting to Truman on September 9, Wedemeyer attacked the use of force by the Communists, as well as the economic policies and widespread corruption of the Nationalists. By year's end, Mao's forces completely controlled Manchuria and also advanced on Yan'an. Nearby Korea remained divided between the American and Soviet zones of occupation after the failure of a joint commission to agree on a unified democratic government for the peninsula. In Japan, where General MacArthur served as the occupation's proconsul, the Allied constitution for the country provided for democratic reform, political parties, labor organizations, women's suffrage, and a for-defense-only military establishment. In India, Louis Mountbatten, now Earl Mountbatten of Burma and Attlee's new Viceroy (later Governor General), offered on June 3 the British Government's plan for separate Hindu and Muslim nations (India and Pakistan, respectively). Jawaharlal ("Pandit") Nehru, Mohandas K. ("Mahatma") Gandhi's principal aide in the long and mostly nonviolent struggle after World War II by the Indian National Congress for independence from Britain, became India's Prime Minister. On the same day, Pakistan began its existence under the leadership of Mohammed Ali Jinnah, leader of the Muslim League, as Governor General, and Liaquat Ali Khan as Prime Minister. Pakistan received less territory (in separate halves) for its large population of Muslims in the northwestern and eastern parts of the former British India. Both India and Pakistan claimed Kashmir.

In the Pacific, the United States assumed responsibility for the U.N. trusteeship of the Pacific islands formerly occupied by Japan. Truman's Executive order of July 18 provided an interim government,[184] under the Secretary of the Navy, for the U.N. Trust Territory of the Pacific Islands (TTPI), when, on the same day, Congress authorized the President to approve the trusteeship agreement for the former League of Nations' mandate.[185] The TTPI, established on April 1 and approved unanimously by the U.N. Security Council on the following day, encompassed some 3 million square miles of ocean and 96 islands totaling 687,000 square miles in the Carolines, the Marshalls, and the northern Marianas, inhabited by more than 50,000 people. The U.N.'s Trusteeship Council monitored all such territories, but the United States held veto powers over any political changes in, access to, or operations on these strategic trusteeship islands. The United States also joined Australia, Britain, France, The Netherlands, and New Zealand in signing an agreement in Canberra on February 6, 1947, that established a South Pacific Commission "to encourage and strengthen international cooperation in promoting the economic and social welfare and advancement of the non-self-governing territories in the South Pacific," in accordance with the U.N. Charter, and to help maintain "international peace and security." On January 28, 1948, Congress approved "[n]ot more than $20,000 annually" for U.S. membership and participation in the Commission.[186]

President Truman did not ignore pressing military and civilian domestic issues that included the reorganization of the Federal Government, Presidential succession, business-labor relations, discrimination in Federal and other hiring practices, and concern about the loyalty of public servants. On July 7, 1947, Congress and Truman established a Commission on Organization of the Executive Branch of the Government,[187] chaired by former President Herbert Hoover, to recommend improvements in economy and efficiency in and improved service by the executive branch. The President, the Senate's temporary president, and the House's Speaker

each chose four members, two from their branches and two from private life. Dean Acheson, who resigned as Under Secretary of State on June 30 to return to his law practice, served as the Hoover Commission's Vice Chairman. Navy Secretary Forrestal, U.S. Civil Service Commissioner Arthur S. Flemming, financier Joseph P. Kennedy, Sr., and three chairmen of congressional Committees on Expenditures in Executive Departments also served as commissioners. Subsequent legislation provided $750,000 for salaries and expenses,[188] and authorized "the temporary or intermittent services of experts or consultants or organizations."[189] The Commission established 18 task forces to evaluate: (1) personnel, with Vannevar Bush, Senator Byrd, and David Lilienthal; (2) supply; (3) records management; (4) statistical agencies; (5) departmental management; (6) fiscal, budget, and accounting activities; (7) national-security organization, with 13 members, including Robert Patterson, and chaired by Ferdinand Eberstadt; (8) foreign affairs, chaired by Harvey Bundy, with Henry Stimson as his adviser; (9) Post Office; (10) revolving funds and business enterprises; (11) water resources projects; (12) natural resources, including Isaiah Bowman and Homestake Mining's president Donald McLaughlin; (13) agricultural activities; (14) regulatory commissions; (15) medical services; (16) public welfare; (17) public works; and (18) lending agencies.

Later in July, Congress and the President acted to change the order of Presidential succession and to improve the armed forces. On July 18, the Presidential Succession Act revised the 1886 law to make the Speaker of the House third in succession to the President and Vice President, after the "removal, resignation, death, or inability"[190] of both. On July 26, Congress passed and Truman signed an act to "promote the national security" by placing all branches of the armed services under a National Military Establishment led by a Secretary of Defense, establishing or confirming the subordinate Departments of the Army, Navy, and Air Force, and correlating the new National Military Establishment's activities "with other departments and agencies of the Government concerned with the national security."[191] Forrestal and Eberstadt, Forrestal's friend and adviser since their years together as Princeton students before World War I, proposed this arrangement in 1945 to oppose George Marshall's and many generals' scheme for a defense department dominated by the Army and its Air Forces. Truman nominated and the Senate confirmed Forrestal as the new but reluctant Secretary of Defense as of September 17. Forrestal's service secretaries included Kenneth Royall (Army), John Sullivan (Navy), and W. Stuart Symington (Air Force). The new law created a Central Intelligence Agency (CIA) that evolved during 1942–47 from the Office of Strategic Services, the Assistant Secretary of War's Strategic Services Unit, and the National Intelligence Authority's Central Intelligence Group. The statute established a formal Joint Chiefs of Staff of four members, with a Joint Staff; a National Security Council (NSC), composed of the President, Vice President, Secretaries of State and Defense, the Chairman of the JCS, and the CIA's Director; a War Council of the service secretaries and chiefs to advise the Secretary of Defense; a National Security Resources Board (NSRB), chaired by a civilian; a Munitions Board, with a civilian chair; and a Research and Development Board, also chaired by a civilian, to replace Vannevar Bush's Joint Research and Development Board. The Federal Bureau of Investigation (FBI) remained responsible for domestic intelligence and security.

As the Office of the Secretary of Defense began its operations, the reconversion of the Nation's industries to peacetime operations was virtually complete, but their relations with labor continued to pose problems, as did questions concerning the loyalty of Federal employees and ensuring equal civil rights to all Americans. On April 1, 1947, bituminous-coal miners again walked out. In response, the 80th Congress passed, over Truman's veto, a bill on June 23 to "amend the National Labor Relations Act."[192] The new law, better known as the Taft-Hartley Act, significantly affected business-labor relations by eliminating the closed shop, permitting

the States to enact right-to-work laws, requiring union leaders to affirm that they were not members of the Communist Party, and allowing employers to sue unions for contract violations and damage. The law also required 60 days' notice for ending contracts, stopped employer collection of union dues, banned political contributions by unions, established a Federal Mediation and Consolidation Service, and authorized 80-day cooling-off injunctions for strikes that endangered the Nation's health or safety. Despite Federal seizure of the mines and extensive mediation between owners and unions, the coal-miners' strike continued until December 1. On March 21, Truman signed an Executive order[193] authorizing the Attorney General and the FBI to investigate the loyalty of all Federal employees and dismiss any found disloyal, an action that led to similar programs outside the Government. Earlier that month, Krug's Secretarial order established an Interior Department Loyalty Board[194]; its three members investigated the backgrounds of all employees and new hires. On July 26, the President's Committee on Civil Rights, established by Executive order,[195] reported its findings in "To Secure These Rights."

As the new fiscal year began on July 1, 1947, USGS dependence on outside finances rose above 50 percent for operations by and salaries of its staff of 3,320 persons. The direct appropriation of about $10,091,000, the largest sum yet received, represented an increase of nearly $382,000, or about 4 percent more than the similar funds provided for fiscal 1946–47. The direct appropriation for fiscal 1947–48 was some 54 percent of the USGS request, and the direct and supplemental appropriations actually received ($10,176,000) made up more than 45 percent of the total of the $22.4 million eventually available to the agency. Of the more than $12 million the USGS received from other organizations, about $11 million came from four sources. The National Military Establishment provided nearly $4 million, mostly from the Army; States, counties, and municipalities shifted some $2.8 million; and the AEC and the USBR each transferred about $2.1 million.

In fiscal year 1947–48, Bill Bradley's Geologic Branch managed about $5,568,000, an increase of some $2,454,000 from 1946–47. The nearly $2.14 million transferred from the AEC to fund the search for uranium-bearing deposits and related projects formed the major portion of the growth in Branch funds. Transfers from the USBM and the USBR fell by a total of $136,000, but military sources, especially the Army Engineers, and the States, counties, and municipalities provided modest increases. Continuing reorganization, aimed at using its staff and funds more effectively and efficiently, yielded three additional Branch changes during the year. On July 15, 1947, Wrather and Bradley reassigned Hugh Miser[196] to Bradley's Special Research Staff to serve as their adviser in fuels geology, conduct fieldwork in the Mid-Continent region, and aid the revision and preparation of State geologic maps. Carle Dane succeeded Miser as Chief of the Fuels Section. Edwin Goddard returned to succeed Don Carroll as head of the Geologic Information and Reports Section.

In other managerial and organizational changes within the Geologic Branch, Thomas Hendricks took over the Trace Elements Unit from Frank Stead, who shifted to lead the TEU's technical planning and development. An AEC–USGS conference on July 28 confirmed the TEU's role as Bradley's coordinating group for AEC-funded work by five of the Branch's Sections—Geology of Metalliferous Deposits, Geology of Nonmetalliferous Deposits, Fuels, Geochemistry and Petrology, and Geophysics—using the AEC's funds of $850,000 for personal services, $1 million for equipment, and the remainder for other expenses. The TEU's new name, the Trace Elements Planning and Coordination Office (TEPCO), reflected its increased responsibilities, funding, operations, and staff, which grew from 12 to several hundred people during 1947–48. On August 1, Wrather and Bradley also abolished the Geology of Metalliferous Deposits Section and the Geology of

Nonmetalliferous Deposits Section and transferred "their functions, personnel, records, and equipment" to the new Section of Mineral Deposits. They gave the new Section's two units, Mineral Investigations and Mineral Resources, additional responsibilities, respectively, for "physical exploration by sampling, trenching, drilling, and such other exploration, except geophysics," and "continuing evaluation of the nation's mineral resources and preparation of systematic reports thereon."[197] That Survey order returned to research former Section Chiefs Edwin McKnight and Ralph Van Alstine and appointed Olaf N. Rove, who shifted from the WPB to the USGS in 1946, to lead Mineral Deposits.

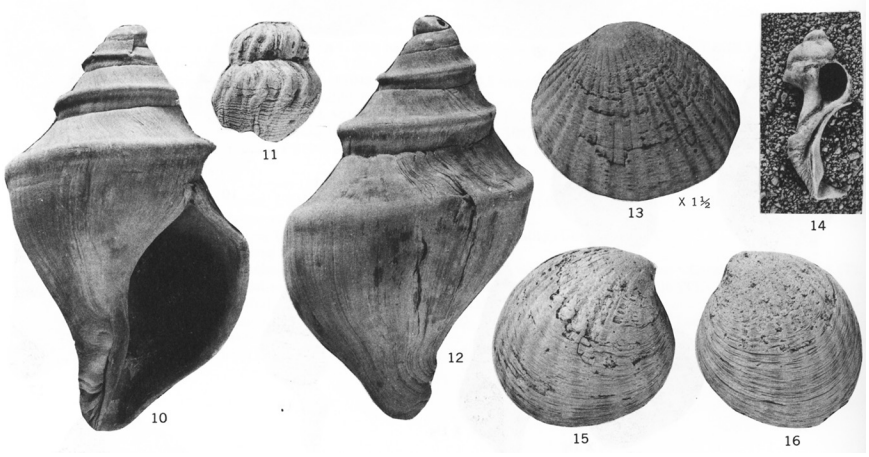
With significantly increased funds and under managers old and new, members of the Geologic Branch began or continued work on mineral deposits, geochemical prospecting, and regional studies, marked by the increasing use of photogrammetric aids. Branch geologists undertook 71 separate investigations of mineral deposits in 28 States—24 of these studies covered copper, lead, and zinc, and 15 others dealt with deposits of iron and ferroalloy minerals. They began an intensive study of uranium in phosphate deposits in Florida, Idaho, Montana, and Utah, gave considerable attention to the geology of pegmatites as sources of beryllium, feldspar, mica, tantalum, and lithium minerals, and continued investigations of alunite, bentonite, fluorspar, magnesite, mercury, potash, talc, and granites. Work also included five new exploratory drilling projects, one each in Arizona, Colorado, Idaho, New York, and South Dakota, of which three were completed. As U.S. reserves of aluminum and its ores now seemed sufficient for projected needs, the Branch devoted less time to work on that commodity, but estimates began to change after Reynolds Metals introduced aluminum foil on September 16, 1947. Geochemical prospecting for mineral deposits in Arizona, Colorado, New York, Tennessee, Utah, and Wisconsin involved new rapid analytical tests developed for use in the field. Branch geochemists also began greenhouse experiments to grow plants in soils containing known concentrations of copper, lead, and zinc to obtain background data on plant behavior in mineral-deposit environments. Regional studies were made in 19 States to delineate new areas with geologic relations favoring occurrences of oil and gas; they ranged from detailed surface studies of the stratigraphy of the Coast Ranges to subsurface correlations of samples, cuttings, and cores from deep wells in Florida, and from investigations of oil-bearing formations in Texas to detailed, bed-by-bed, correlations of New York's black shales. The USGS published 19 maps and charts of fuel-related investigations in Alabama, Colorado, Georgia, Mississippi, Montana, New Mexico, Ohio, Utah, Virginia, and West Virginia. Map sales from this program reached a total of 90,000 copies; to make the information more promptly available, the USGS set up sales offices at Billings, Casper, Denver, Los Angeles, and Tulsa.

During fiscal year 1947–48, Paul Averitt and other Geologic Branch scientists also began the long-needed reappraisal of U.S. coal reserves, aided by the statutes of 1941 and 1947 that permitted Federal inspections of coal mines. They nearly completed a study and computation of available data on Montana's coal reserves, now important as a potential source of synthetic fuels, and an accompanying coal-resources map of the State. Bill Bradley and Carle Dane expected the Montana investigation to serve as a pattern for similar studies in other States. In conjunction with the USBM's investigations, the USGS published a preliminary report on the geology and reserves of coking coals in the Paonia field in Colorado, while fieldwork continued on that State's Durango field, thought to contain coking coal, and North Carolina's Deep River coal field. Late in the fiscal year, fuels geologists also began the long-needed investigations of the Pacific Northwest's coals in Washington's Lewis and Thurston Counties. New investigations of the geology and structure of Pennsylvania's anthracite fields commenced with a study of a part of the Western Middle anthracite field.

During the year, USGS geologists continued work in the Missouri River Basin, planned for similar studies in the Columbia River Basin, and began investigations on the Continental Shelf in the Gulf of Mexico. They conducted six field projects in the Missouri River Basin during 1947–48 as part of Interior's development program. During 1946–48, the USGS issued maps, at 1:500,000 or 1:750,000, showing the occurrences of sand and gravel, construction materials, deposits of metallic and nonmetallic minerals, and other raw materials in areas of the Missouri River Basin in Colorado, Montana, Nebraska, North Dakota, South Dakota, and Wyoming. Plans also were completed for studying the geology and construction materials in and around Denver and San Francisco and on part of Puerto Rico (in cooperation with its water authority). Other plans included a 20-year effort in the Columbia River Basin, based on the programs of Federal construction agencies, and similar long-range investigations in other areas. Branch geologists continued an experimental gravity survey and program of oceanographic studies, begun in June 1947, on the Continental Shelf in the Gulf of Mexico, as commercial drilling for petroleum continued off Louisiana and Texas, where operations began in Black Duck Bay in 1917. The Branch's program, largely financed by the Office of Naval Research, was carried out in cooperation with the ONR and Woods Hole Oceanographic Institution.

The Branch's program for mapping the conterminous United States at 1:62,500 continued to produce during fiscal year 1947–48 only one-sixth of the 400 quadrangles needed each year to complete by 1980 the mapping of the remaining 12,000 quadrangles. Wrather called for a new plan to increase mapping output, one that would combine and better utilize the resources of the Federal and State Governments, academia, and industry. As a first step in securing this cooperation, the USGS completed bibliographic indexes to all published geologic maps in each State. Wrather also emphasized that geologic mapping helped to develop new concepts about the nature of crustal motion, the formation of glacial deposits, and the geological processes involved in soil development.

USGS geologists also extended their studies of Alaska's mineral resources during fiscal year 1947–48, for which Congress provided $250,000 in direct appropriations and the Navy transferred $173,000, principally to support work in NPR–4. On March 28, 1947, George Gates, Walter English, and three representatives of Arctic Contractors met in Los Angeles to discuss the whole program in NPR–4 and offer advice to the Operating Committee before it met in Washington. The group recommended expanding seismic-shothole drilling by adding shallow-core wells to recover fossils for stratigraphic correlation, conducting gravity and seismic investigations of the magnetic-anomaly areas to determine their significance, and drilling the Fish Creek seepage west of the Colville Delta. English told



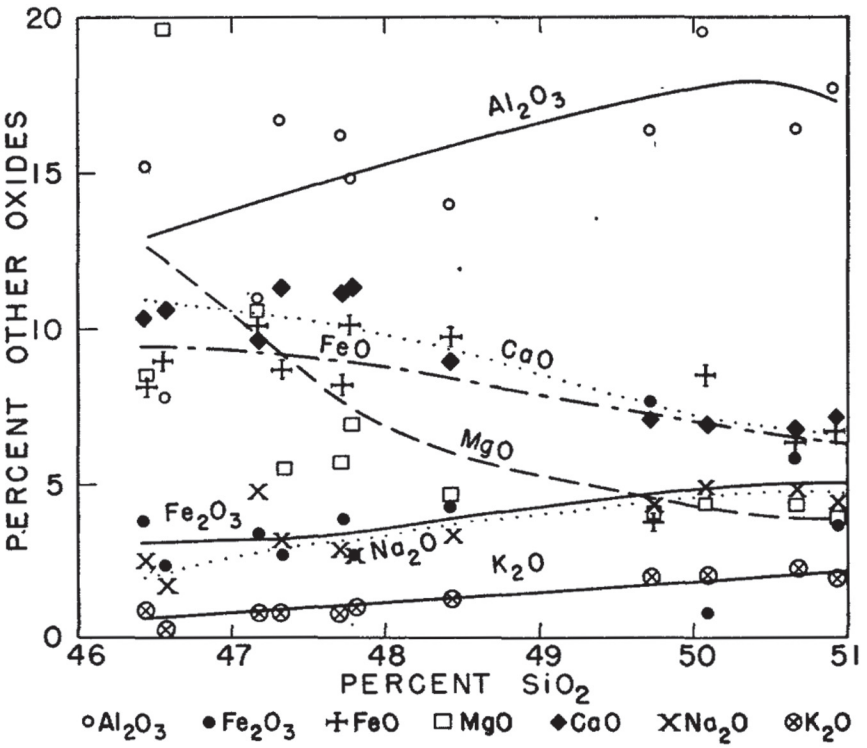
Geologist L.J. Barksdale, while serving with the USGS Navy Oil Unit, collected these specimens of the pelecypod *Cardita* (figs. 13, 15, 16), the gastropods *Buccinum* (fig. 11), *Neptunea* (figs. 10, 12) and *Volutopsius* (fig. 14), and other fossil mollusks from exposures of the Gubik Formation along the Meade River during the exploration of Alaska's Naval Petroleum Reserve No. 4 in 1944–53. USGS paleontologist Stearns MacNeil, in identifying, dating, and correlating the late Cenozoic marine invertebrates from this and other formations at Carter Creek, Ocean Point on the Colville River, and elsewhere on the North Slope, extended his investigations of Cenozoic marine faunas that began with studies of coastal-region strata in the conterminous United States. In subsequent years, MacNeil analyzed marine invertebrate fossils from the oil-bearing strata in the Gulf of Alaska Tertiary Province. (From MacNeil, 1957, pl. 14 [part]; figures 10–12 and 14–16 originally shown at × 1; figure 13, at × 1.5.)

Commodore Greenman about the group's increasing interest in "the northern and northeastern portions of the Reserve as being the most hopeful" and gave "his opinion that the funds allotted were not sufficient to attain fully the major objective of [the] Pet-4 [exploration program]—to determine the oil possibilities of the Reserve." Greenman decided that "basic investigations should emphasize * * * geologic structural features that could be drilled before the spring of 1949" to "have some oil wells to justify to Congress the need for additional funds."[198] Greenman immediately ordered that the Umiat test well 2 be drilled to about 3,000 feet, for a projected cost of $260,000. When Greenman, English, Colonel O.F. Kotick of the Army-Navy Petroleum Board, William Wrather, Lewis MacNaughton, and the rest of Operating Committee convened for their sixth meeting on April 15, George Gates oversaw the reports of progress and plans by his USGS Navy Oil Unit's geologists and geophysicists—Robert Chapman, George Gryc, Fred Keller, Jr., Thomas G. Payne, Karl Stefansson, and Edward Webber. Gryc noted the Army's promise to complete by June the trimetrogon and vertical photography required by the field parties.

Gates' reconnaissance by air of specific parts of NPR–4 in June modified the committee's directions for the seismic, gravity, and geological surveys. Gryc, Stefansson, Raymond M. Thompson, Webber, and Charles L. Whittington led the five parties, each with at least two geologists, in NPR–4 during the 1947 season. The Navy funded four of George Gates' five field parties, and the USGS financed Gryc's team as the fifth group. Working east of NPR–4 in the Shaviovik-Canning Rivers region, Gryc's party discovered oil-bearing sands and decided that "older rocks to the east pitching under the flatter terrain to the west," not change "in direction of fold axes in the mountains," caused the "great bend of the north front of the Brooks Range."[199] During the season's work, team members increased their understanding of the regional geology and located a large basin of deltaic-type Tertiary deposits underlying the flat Arctic Plain in the northeastern part of the Reserve. The oil seeps at Fish Creek and Cape Simpson indicated source beds. Oil-bearing sands, Payne, believed, would be limited largely to shoreline belts within the deltaic basin. Payne's explanation of stratigraphic "facies changes * * * subsequently was very useful in planning the program."[200] As part of the exploration effort, Simpson test well 1 was drilled to 6,094 feet, Umiat test well 2 was drilled to 6,212 feet, and core-test wells were completed at Barrow, at two sites between the Ikpikpuk and Oumalik Rivers, at Sentinel Hill, and at Skull Cliff. The Army Engineers supported the Navy ships of the Barrow Expedition 1947 and supervised the installation of a subsidiary station and tower at Skull Cliff and a monitoring station at Barter Island, as part of a long-range navigation (loran) system based in northern Canada. In September, members of the Senate's Committee on Interstate and Foreign Commerce and the House's and Senate's Committees on Public Lands toured NPR–4. By the end of December, the USGS completed 75 percent of its 1:48,000-scale planimetric maps and 60–95 percent of the Army Map Service's 1:250,000-scale sheets for Barrow, Umiat, and Wainwright, but to finish them, the USGS needed complete vertical-photographic coverage.

In Hawaii, in November 1947, the Hawaiian Volcano Observatory[201] returned to the USGS, its home during 1924–35 before it was transferred to the National Park Service. Earlier in 1947, after Wrather again visited Alaska, Harry Ladd, returning from Bikini, interrupted Wrather's brief vacation in Honolulu with a request to join him "for a trip to Mauna Loa." "The trip, though unexpected," Wrather recalled, "came at an opportune time" because "[t]he Survey expected to take over the Volcano Observatory from the National Park Service and I wanted to discuss the situation with Mr. [Francis R.] Oberhansly [Oberhansley], Superintendent of the Hawaii National Park." Oberhansley met Wrather and Ladd at the Hilo airport and took them on a tour of the big island, accompanied by Gordon Macdonald and Howard Powers. At the HVO, still led by Ruy Finch, they enjoyed

The percentages of the principal oxides compared to those of silica in this diagram of the composition of andesitic lavas from Mauna Kea on Hawaii showed that "most of the curves are very similar to those from Haleakala Volcano" to the northeast. Geologists at the USGS Hawaiian Volcano Observatory collected samples of lavas new and old as part of their geochemical and geophysical studies and monitoring of activity by the islands' volcanoes to increase their understanding of eruptions and their ability to predict them. (Quotation and graph from Macdonald, 1949, p. 83 and fig. 1.)



"a long session with" Thomas Jaggar, who lived near Volcano House. This trip, Wrather believed, gave him his "first comprehensive understanding of the volcano problem as is it concerned the Survey." On returning to Honolulu, Wrather, guided by Chester L. Wentworth, of the city's Board of Water Supplies, and other hydraulic engineers who "were interested in both the Survey's water program, and in an effort to secure new topographic maps of the Islands," looked at the city's water system and "the underground facilities of the Navy at Pearl Harbor."[202] Max H. Carson, the Water Resources Branch's District Engineer in Hawaii since 1924; groundwater geologist Dan A. Davis, who succeeded Carson in 1951; and geologist and hydrologist Doak C. Cox, who left USGS strategic-minerals investigations in 1946 to lead the Hawaiian Sugar Planters Association's water research and development, arranged for Wrather to view the progress of some of the Water Resources Branch's projects and related activities on Oahu and Kauai.

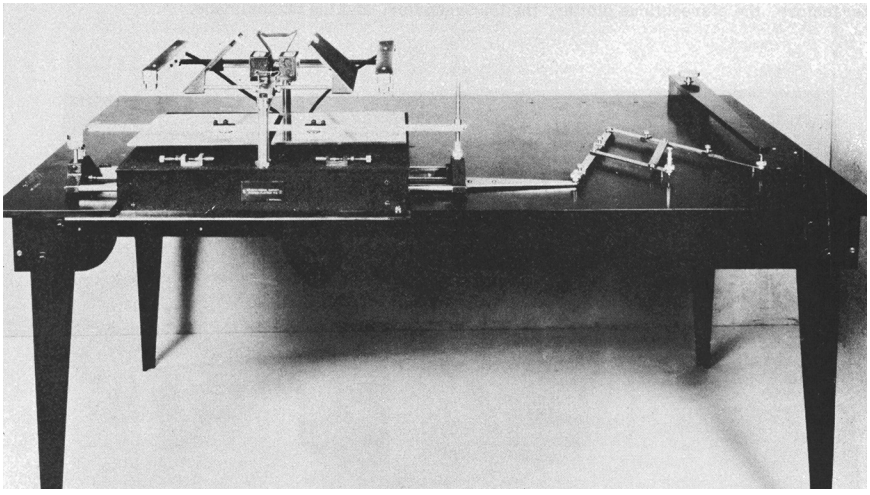
The advent of fiscal year 1947–48 also marked a new high in funds for the USGS Topographic Branch and the reestablishment of the Board on Geographic Names. On July 25, 1947, the day that Congress and the President agreed on USGS appropriations for the new fiscal year, they also revived the Board, originally founded in 1890, to "provide a central authority for standardizing such names among the Federal departments."[203] To support Branch operations in 1947–48, Chief Topographic Engineer Gerald FitzGerald managed a total of about $7,708,000, an increase of about $1,063,000 from fiscal 1946–47. Of this sum, $3 million came from the direct appropriation, more than $2.6 million in transfers from the National Military Establishment (74 percent of which came from the Army Engineers), nearly $1,076,000 from the Bureau of Reclamation, and some $713,000 from States, counties, and municipalities. The USGS also completed formal agreements with the Army Engineers, the USBR, and the USCGS. By these accords, the USGS would provide, insofar as possible, for all their map needs. If the three agencies found it necessary to undertake any special mapping, they agreed to prepare these maps to standard specifications so that the USGS could use

them as well. Members of Ronald Wilson's Geodesy and Control Surveys Section completed developing the electrical-survey-net adjuster for the routine adjustment of leveling nets and transit-traverse surveys. They also extensively field tested two commercially designed instruments that continuously measured elevation while being carried in automobiles or trailers traveling at 10 to 15 miles per hour.

Russell Bean's Photogrammetry Section completed repairing and evaluating nearly all the former German equipment, placed most of it in use, and continued to prepare several designs for new projectors and plotting instruments. The basic principles for one of these new instruments, the Kelsh plotter, were developed outside the USGS by 1943 and were based in part on German equipment designed before 1935. In 1934, Harry T. Kelsh, the stereoplotter's inventor, joined the Cartography Division of the USDA's Soil Conservation Service, where he quickly became involved in photogrammetry and devised and tested an improved slotted-template method of map control. As head of the Division's Survey Section in the USDA's complex at Beltsville, Kelsh continued to "develop a simplified, economical plotter capable of projecting full-size images at large magnification."[204] At Russell Bean's suggestion, Charles Davey, James Buckmaster, and Joseph P. Burns went to Beltsville to see Kelsh and the 1946 version of his prototype plotter (of 1945) and its contact-sized diapositives. Kelsh, anxious to leave the SCS, agreed to work half time for the USGS if the agency would help him to design and build an improved and commercially viable plotter. Burns joined the Kelsh team's effort to design and develop standard and wide-angle plotters, while Buckmaster worked on improving the Multiplex. Construction began on an improved graph rectifier that would convert the record charts from airborne-magnetometer surveys to a more usable form.[205]

One of the Topographic Branch's regional units also conducted experimental work during fiscal year 1947–48. Over a 10-day interval late in 1947, engineers in Robert O. Davis' Rocky Mountain Division used a helicopter to carry a payload of 200–250 pounds on each of 24 round trips, traveling a total of about 650 miles, from Cañon City to mountaintop stations and other high stations in nearby parts of Colorado. The Division then chartered three helicopters for work in Alaska during the summer of 1948.

The Topographic Branch's reorganization plans called for ensuring that field offices performed all possible production steps. Installing additional equipment and transferring or hiring additional personnel increased the work capacity of the Rocky



USGS topographer Richard O. Mahan developed in 1942 a "comparatively simple stereoscopic mapping instrument" as a plotter to use "ordinary contact prints of [7-inch by 9-inch or 9-inch by 9-inch vertical] aerial photographs." The Mahan plotter enabled "plotting on a constant scale and appropriate tilt correction" but, unlike the Multiplex, did "not provide refinements such as correction for lens distortion." The "adaptable, low cost, and accurate" Mahan plotter remained in use through the 1940s. (Quotations from Thompson, 1958, p. 14 and fig. 12; see also Van Camp, 1945, figs. 1, 2.)

Mountain Division's headquarters in Denver. Plans also were completed for a new building at the Central Division's headquarters in Rolla. Each field office received a copy of "Topographic Mapping by Photogrammetric Methods," a training film for employees and a briefing vehicle for visitors and other interested groups. During fiscal year 1947–48, Topographic Branch engineers mapped nearly 36,000 square miles in 38 States and Puerto Rico. Mapping in Alaska, by topographers now sent from the Denver office, involved projects in the south-central part of the Territory at Homer, near Cantwell and Healy along the Alaska Railroad, and to the southeast in the Stikine River Valley north of Wrangell. The Branch published a new 1:5,000,000-scale base map of Alaska in 1947. One topographer advised the U.S. Air Force (USAF, the former Army Air Forces) while it and the Navy secured vertical photography of priority areas. The Trimetrogon Section surpassed its previous record by completing more than 700,000 square miles of entirely new compilation and revising nearly 800,000 square miles already covered. In another significant change in Branch operations, its personnel prepared for multicolor photolithography 226 of the 240 maps edited for publication, which marked a major shift away from engraving.

Carl Paulsen's Water Resources Branch received about $6,738,000 for its operations in fiscal year 1947–48, a sum just $372,000 more than in 1946–47. Of this total, Congress directly appropriated $3,110,000, States, counties, and municipalities supplied nearly $2,027,000, and the remainder came from other Federal sources—about $690,000 from the USBR, slightly more than $586,000 from the Army Engineers, and some $106,000 from the State Department.

From the Water Resources Branch's more than 100 principal offices, its personnel conducted investigations in nearly every State and in the Territories of Alaska and Hawaii. Members of Joseph Wells' Surface Water Division operated some 6,000 gaging stations, nearly 800 more than in the previous year, throughout the States and Territories, some of them in conjunction with interstate compacts or in accordance with international-treaty obligations. The Division expanded its gaging program in Alaska, begun with 7 stations in 1947, to 35 sites. Division personnel experimented with a new snowmobile, developed and fabricated in cooperation with the Soil Conservation Service, for making winter observations in remote mountain areas. They also completed the laboratory observations, begun in 1946–47, on the effect of backwater on river discharge and began analyzing the data. Groundwater investigations in nearly 400 projects were conducted in almost every State, Alaska, Hawaii, and Puerto Rico. In Arizona, members of Nelson Sayre's Ground Water Division used geophysical methods to locate supplies of underground water in critical areas where previous efforts by private interests proved unsuccessful. In North Carolina's Piedmont area, statistical studies of the yields of wells in relation to several factors developed criteria for selecting well sites that could be applied over the entire area from Pennsylvania to Alabama. Stuart Schoff spent a month during October–November 1947 in Kuwait evaluating available data to try to locate sources of potable groundwater; he thought prospects were very poor, but his recommended sites in previously unexplored locales were not tested by drilling. Employees of Kenneth Love's Quality of Water Division analyzed the chemistry of some 17,500 samples, many in cooperation with 13 States. The Division established two new field laboratories: one was in Schuylkill Haven, Pennsylvania, and the other was in Columbus, Ohio, the latter to serve Federal and State interests throughout the lower Ohio River Basin. Division personnel increased substantially the extent and scope of their sediment-measuring activities by collecting at least daily at 69 stations, and intermittently at 72 additional sites, on streams in the Brandywine, Schuylkill, Missouri, Washita, Colorado, and Rio Grande Basins.

Harold Duncan's Conservation Branch received nearly $1,043,000 to support its work during fiscal year 1947–48, a loss of about $33,000 from the previous year. The $9,000 increase for mineral leasing did not offset a decline of nearly $43,000 in direct appropriations and USBR transfers for land classification. Branch personnel acted on more than 28,900 cases involving the disposal of Federal lands or the exercise of the Government's right to explore for and produce minerals from lands under Federal jurisdiction, an increase of nearly 50 percent over the previous year. They also determined the potential for fissionable source material of more than 3,700 parcels during the 5 months prior to Truman's Executive order of December 5, 1947, that required reserving to the United States the lands that contained uranium, thorium and similar materials.[206] The Conservation Branch detailed one of its geologists to the Department of Justice for the entire fiscal year for work with the proceedings in the case of the *Confederated Bands of Ute Indians* v. *United States*. On public lands, the Branch supervised nearly 13,440 oil and gas properties, an increase of 19 percent over the preceding year. Branch personnel approved 41 new unit plans; 55 percent of the petroleum, 62 percent of the natural gas, and 80 percent of the gasoline and butane obtained from the public lands during the year were produced under endorsed unit agreements. Branch members continued to monitor, on the Navy's behalf, operations under lease in NPR–1 and NPR–2, where production generated royalties of nearly $1.1 million to be added to the almost $294,000 from production in the Army's Rio Vista gas field. They also oversaw operations on 956 mining properties that produced coal, fluorspar, lead, phosphate, potassium, sodium, and zinc. The record production of potassium in fiscal 1947–48 exceeded for the first time the royalty value of coal output.

On August 7, 1947, Congress and the President, through the Acquired Lands Leasing Act,[207] extended the 1920 Mineral Leasing Act's provisions to all acquired-land minerals and, with few exceptions, the minerals acquired by Federal agencies. The management of the disposition and use of minerals on all U.S. lands thereby passed to the Interior Department in an effort to ensure a coordinated Federal policy and program. Eastern-coal producers and the oil industry, looking to the future generation of synthetic fuels from coal, showed more interest during fiscal year 1947–48 than in previous years in acquiring western coal lands. Members of the Conservation Branch's Mining Division cooperated with the National Petroleum Council in selecting sites for producing petroleum from solid fuels. Using 500 million tons of bituminous-coal and lignite reserves would require 50 million to 75 million gallons of water each day but would yield an estimated 50,000 barrels of oil daily for 30 years, or a little more than 1 barrel per ton of solid fuels. To the military authorities, the Committee recommended 15 sites—5 in North Dakota, 4 in Montana, 2 each in Colorado and Wyoming, and 1 each in Alaska and New Mexico.

Kirtley F. Mather's assessment of petroleum available now and in the future, presented at the British Association for the Advancement of Science's meeting in Dundee, Scotland, on August 29, 1947, suggested that U.S. coals and oil shales could provide 2 billion barrels of synthetic crude per day for 1,000 years, provided costs were borne, and that British coals could generate a similar volume for hundreds of years. He said nothing about the cost of repairing, or at least mitigating, mining's adverse effects on the environment or water needs. Mather, who worked part time with the USGS during 1911–45, now provided these estimates, based principally on industry data, within the greater context of evaluating the decline in America's proved reserves of petroleum and the rise in production from them in the decade since 1936. He noted that U.S. reserves comprised 30 percent of the world's total, but U.S. production accounted for 60 percent of global production. Mather, echoing Harold Ickes, suggested that "if present trends continue, 10–20 years from now the United States will be a 'have-not nation.'"[208] The Soviet Union, Kuwait, Iran, Iraq, the Arabian Peninsula, and the East Indies then would be "haves," but the United States, Britain, and The Netherlands now either controlled

or influenced the reserves of the last five of these six countries or areas and U.S. interests in South American reserves rose to 75 percent.

Mather recommended continued exploration for petroleum combined with maximum production, better recovery, efficient use, and the development of solar, nuclear, and other sources of energy. Mather thought that "world petroleum reserves are quite adequate to meet world needs for half or three-quarters of a century to come" but only if they were used well with "almost complete freedom for distribution of the oil and its products from regions of supply to all parts of the world, regardless of political boundaries." Like Charles Leith and others in the immediate postwar years, Mather felt that "mineral interdependence in the modern world * * * should be thoroughly comprehended by every person concerned with international relations."[209] Leith, now retired, continued to serve on the AEC's Combined Development Agency (founded in 1944 as an Anglo-American effort to secure increased supplies of uranium and thorium), the National Military Establishment's Research and Development Board, the National Security Resources Board, and the National Research Council's Minerals and Metals Advisory Board. In a symposium on "Present Trends and International Implications of Science," sponsored by the National Academy of Sciences and held in Philadelphia during October 1946, Leith again emphasized the importance of the growing number of bilateral and regional agreements on mineral resources. He hoped these arrangements would evolve into a system "of mineral supply by international agreement, either for industry or for security, [which] will tie up the world's mineral resources in a way that would be an effective deterrent to war."[210]

On August 6, 1947, one day before Truman signed the extended-leasing bill, he vetoed another measure intended to establish a national science-research foundation, even though he continued to think it was needed to help pioneer new courses in meeting America's needs. In the 80th Congress, Senator H. Alexander Smith (R–NJ) chaired the bill's parent subcommittee. Smith, favoring Vannevar Bush's version of the science foundation, helped to revise the Kilgore-Magnuson compromise measure in 1946. On February 7, 1947, as Merton England recorded, Smith introduced his own bipartisan bill, based principally on the Magnuson version and cosponsored by Cordon, Fulbright, Magnuson, and two other Senators. Smith's version, and similar bills introduced in the House, included a board of 48 (later 24) part-time members, each appointed by the President for an 8-year term, and a 9-member executive committee that would choose a full-time director whom it would control and supervise. Representatives from some 75 organizations met in Washington on February 23, formed an AAAS-sponsored Inter-Society Committee for a National Science Foundation, and elected its executive committee, chaired by Cornell's president Edmund M. Day and including Isaiah Bowman and psychologist and OSRD-veteran Dael Wolfle among its 8 other members. Smith ignored the new Committee's recommendations. During the Senate's debate on the Smith bill during May 14–18, opponents defeated amendments allowing the President to appoint the foundation's director and restoring the social-sciences and geographic-distribution-of-funds components, but they accepted an increase of the foundation's public-health activities, including cancer research (the House added poliomyelitis). On July 22, the conference version of Smith's bill passed Congress and went to the White House. James E. Webb, Director of the Bureau of the Budget since July 1946, had warned Bush earlier, and did so again on August 1, that Truman would veto the measure, which the President had discussed with Smith, if it did not give him greater Presidential authority over the foundation.

"With deep regret," Truman vetoed the Smith bill because the measure contained provisions representing "so marked a departure from sound principles for the administration of public affairs"[211] that the proposed national science foundation "would be divorced from control by the people to an extent that implies a

distinct lack of faith in democratic processes." The proposed organization, and its two layers of part-time boards, was "so complex and unwieldy that there is grave danger that it would impede rather than promote the Government's efforts to encourage scientific research." Truman believed that the legislation also would deprive him "of effective means for discharging his constitutional responsibility"[212] by establishing an "Interdepartmental Committee on Science"[213] composed of representatives from the departments and agencies responsible to the President whose chairman, not appointed by or responsible to the Chief Executive, would direct the foundation. Truman thought that the bill's principles, if applied Governmentwide, would yield "utter chaos." He asserted "that our traditional democratic form of government" could properly administer "a program for encouraging scientific research and education."[214] Vannevar Bush thought Truman's insistence on appointing the foundation's director, who would report to the President rather than the National Science Board, would make the NSB primarily an advisory body.[215] As the foundation would work closely with the universities, Bush believed, this would lower both confidence and resistance to political pressure. Bush, although failing for a second year to achieve an OSRD-like foundation, did not join Smith, the legislators, and the scientists who denounced Truman for a solely political decision.[216]

Bush's Research and Development Board, of the National Military Establishment, now was served by a policy council, a full-time staff led by Lloyd Berkner, and six committees. James Conant chaired Bush's Atomic Energy Committee, Hartley W. Rowe led the Aeronautics Committee, and Karl Compton chaired the Guided Missiles Committee. Julius A. Stratton, an electrical engineer and physicist at MIT and Rad Lab veteran, who now directed the Research Laboratory for Electronics, led the Board's Electronics Committee. Geophysicist Roland F. Beers chaired the Board's Geophysical Sciences Committee; he had led in Dallas the Geotechnical Corporation (1936, later Teledyne-Geotech) and Beers and Heroy (1946) and also had advised the NRC, the ONR, and the USGS. Charles H. Behre, Jr., an economic geologist at Columbia University who worked part time for the USGS during 1921–45, led the Geographical Exploration Committee. Merton England noted that Bush, despite losing influence with Truman, still respected him as a leader and looked forward to a successful bill for a national science foundation. So did the President, who closed his message by asking Congress to "reconsider this question" and enact a sound law "early in its next session."[217]

"Science and Public Policy," the four-part report of the President's Scientific Research Board (chaired by Steelman, Assistant to the President since December 12, 1946), appeared shortly after Truman's veto. Truman's subsequent Executive order consolidated economic stabilization, war reconversion, and related Federal functions in a new Office of Temporary Control, and the President made Steelman liaison to and coordinator of the policies and programs of all Federal agencies. "A Program for the Nation," the initial volume of the PSRB's report, echoed "Science—The Endless Frontier" by its beginning assertion:

> **The security and prosperity of the United States depend today, as never before, upon the rapid extension of scientific knowledge. So important, in fact, has this extension become to our country that it may reasonably be said to be a major factor in national survival.[218]**

Steelman's PSRB urged Congress and the President to act in eight principal areas of concern. First, the PSRB's report called on the legislators and Truman to consider increasing "our annual expenditures for research and development as rapidly as" permitted by increases in facilities and trained personnel, so that by "1957 we should be devoting at least one percent of our national income" to such work "in the universities, industry, and the Government." Second, the report also asked that in the next decade greater emphasis be placed on basic and medical research, total expenditures for research and development be doubled, funds for

medical research be tripled, and expenditures for fundamental research be quadrupled. Third, the PSRB recommended Federal support of "basic research in the universities and nonprofit research institutions at a progressively increasing rate, reaching an annual expenditure of at least $250 million by 1957." Fourth, the PSRB called for "a National Science Foundation * * * to make grants in support of basic research, with a Director appointed by and responsible to the President * * * and advised by a part-time board of eminent scientists and educators,"[219] of whom half would be from outside the Federal Government and half would be from within it. As the PSRB's fifth and sixth exhortations, it asked for Federal programs of assistance "to undergraduate and graduate students in the sciences" and "to universities and colleges" for "laboratory facilities and scientific equipment" as integral parts of general programs of "national scholarship and fellowship" and "aid to education." Seventh, the PSRB proposed establishing a Federal committee, "composed of the directors of the principal Federal research establishments," to assist in coordinating and developing "the Government's own research and development programs," to be aided by a review unit in the Bureau of the Budget and a White House staff member responsible for overall liaison. Eighth, the PSRB urged that "every effort be made to assist in the reconstruction of European laboratories as part of our program of aid to peace-loving countries" whose terms required "the maximum contributions toward" restoring "conditions of free international exchange of scientific knowledge."[220]

On December 18, 1947, William T. Golden, who assisted David Lilienthal at the U.S. Atomic Energy Commission (AEC), added a ninth consideration by suggesting to Truman that he appoint his own scientific adviser as well as a scientific advisory committee.[221] Six days later, an Executive order established the Interdepartmental Committee on Scientific Research and Development (ICSRD) "to further the most effective administration of Federal scientific research and development." Representatives of the "Departments of Agriculture, Interior, Commerce; the Army, Navy, Air Force, and the National Military Establishment; the Federal Security Agency; the AEC; the National Advisory Committee for Aeronautics; the Veterans Administration; and the Smithsonian Institution"[222] made up the ICSRD. The President would designate annually the ICSRD's Chairman, who might occasionally establish specific-study subcommittees that could include persons from outside the Federal Government or from agencies not regular members of the ICSRD. On December 26, another Executive order terminated the OSRD, effective December 31, but provided for completing its liquidation through the National Military Establishment.[223]

To aid the international exchange of scientific knowledge, Congress and the President already had approved two measures. On July 1, 1946, they provided for U.S. participation in the United Nations Educational, Scientific and Cultural Organization (UNESCO). On August 1, just before founding the AEC, they established "An American Bridge to World Science"[224] by amending 1944's Surplus Property Act while enacting the bill introduced by Senator Fulbright. To increase scientific communication, reduce parochialism, increase research potential, and contribute to a stable and peaceful world, the new law enabled the use of foreign currencies or credits from such disposals to fund "studies, research, instruction, and other educational activities"[225] abroad by U.S. veterans and other citizens and those by foreign citizens in American schools in their countries or in the United States. To administer these exchange programs, the Fulbright Act also established a 10-member Presidential Board of Foreign Scholarships, to which Truman appointed General Omar Bradley, Ernest Lawrence, Vassar's new president Sarah G. Blanding, and others from academia and government. By the beginning of fiscal year 1947–48, Congress and Truman authorized nearly $138 million in foreign cash or credits for these purposes and divided the sum among 21 participating countries. Australia, Austria, Belgium, Britain, Burma, Nationalist China, Czechoslovakia, Denmark, Egypt,

Finland, France, Greece, Hungary, Iran, Italy, The Netherlands, New Zealand, the Philippines, Poland, Siam, and Turkey each received sums that varied between $20 million for Britain, China, and Italy and $500,000 for Turkey. The Philippines gained its independence on July 4, 1946, as promised by the United States, which retained the 99-year leases on military bases in the new Republic as negotiated on March 14.

Steelman and the other members of the President's Scientific Research Board now staked out an even larger role for science and technology in foreign relations. For a world where many nations still suffered "from extreme poverty due to the war's destruction" and "totalitarian ideas still dominate several areas and continue to impede progress toward a world society of free peoples,"[226] the PSRB's report stressed that

> **[it] is to our national interest to make a maximum effort to restore the conditions of free international cooperation among scientists which existed before parts of the world came under totalitarian domination. It is equally important to our interest, as part of the plans for reconstruction of the devastated countries of Europe and Asia, for us to lend every possible aid to the re-establishment of productive conditions of scientific research and development in all those countries willing to enter whole-heartedly into cooperation with us.**[227]