Chapter 3.
Washington Madhouse, 1941–1943

It is often amusing, and it is sometimes politically profitable, to picture the City of Washington as a madhouse, with the Congress and the Administration disrupted with confusion and indecision and general incompetence. However—what matters most in war is results. And the one pertinent fact is that after only a few years of preparation and only one year of warfare, we are able to engage, spiritually as well as physically, in the total waging of a total war. Washington may be a madhouse—but only in the sense that it is the Capital City of a Nation which is fighting mad.[1]

—Franklin D. Roosevelt

Americans have been prone to consider Washington, almost from the time the city became the Nation's Capital in 1800, as a place of confusion, indecision, and incompetence. The United States' entry into war in December 1941 did not miraculously alter that perception. In some circles, people viewed the two-ocean war as Washington's fault and, for a time, the Capital may well have appeared to be a perfect bedlam as the Government struggled with the manifold problems of global conflict. An equally strong tradition existed in which Americans united behind their Government in times of crisis. Soon after the Japanese attack on Pearl Harbor, the Nation was almost single-mindedly and wholeheartedly engaged in waging total war. On December 13, Congress and the President removed the geographic restriction on the use of U.S. armed forces. A week later, they amended the Selective Training and Service Act of 1940 to extend the ages of males required to register for service to 65 years and of those liable to be called for such service to 45 years.

To describe what went on in Washington during the war, consider Silvio A. Bedini's phrase "Thinkers and Tinkers,"[2] the title of his book about science and technology in early America. Bedini's thinkers were the scientific leaders. His tinkers applied the practical sciences, but not always scientifically, to solve existing problems. The tinkers, undeterred by failure, returned time and time again to the problems until they carried out their tasks. In World War II, the thinkers were the strategists who planned for prosecuting the conflict to victory and winning the peace. The tinkers included scientists, economists, and industrialists in government offices, factories, and laboratories at home and abroad, who persisted until they accomplished their missions. Those tacticians tried to cope with problems involved in rapidly locating raw materials needed for production, fabricating the materials of conflict, and devising new weapons and methods of war. The Japanese successes in the first 6 months of the war made this work even more imperative.

Japan's war plan called for adding to its Greater East Asia Co-Prosperity Sphere the oil and solid fuels, antimony, asphalt, bauxite, chromium, copper, diamonds, gold, iron, lead, manganese, molybdenum, phosphates, rubber, silver, sulfur, tin, tungsten, zinc, and other raw materials of the Southern Resources Area that included Borneo, Burma, Malaya, the Netherlands East Indies, New Guinea, and the Philippine Islands. To protect these and other new acquisitions, Japan's armed forces would establish a wide-ranging defensive perimeter in East Asia and the Pacific and secure it before America could recover from the strike on Pearl Harbor. Japanese strategists estimated that the United States could not mobilize its

own forces and mount a meaningful offensive in the Pacific for up to 18 months. By then, sometime in mid-1943, they expected their cordon to be too strong to be breached and the Southern Resources Area to be exploited effectively enough to enable the military and related products of Japanese industry to equal America's. Surely then, the strategists concluded, the United States would sue for peace, as did China in 1895 and Russia in 1905.

As Admiral Yamamoto predicted, additional Japanese successes in the Pacific followed swiftly after the raid on Pearl Harbor. On December 10, 1941, Japanese aircraft operating from Saigon sank at sea the two British capital ships sent to Singapore by Churchill to deter further Japanese aggression. Their loss left the maritime defense of Malaya and the Netherlands East Indies to a handful of Allied cruisers and destroyers. Also on December 10, Japanese troops captured unfortified Guam and landed on Luzon in the Philippines. Imperial Navy forces overwhelmed the U.S. Marines' garrison on Wake on December 23. Two days later, Imperial Army units took Hong Kong from its British and Canadian defenders. Other Japanese forces secured New Britain's Rabaul, and its magnificent harbor. The Japanese occupied the open city of Manila, as General MacArthur and his American-Filipino army retreated to Luzon's Bataan Peninsula. MacArthur and his staff, ordered out by Roosevelt, left Corregidor for Australia on March 11, 1942, but the general promised to return. U.S. Army planners in Washington wrote off the Philippines and diverted reinforcements to Australia. Bataan fell on April 9, Corregidor surrendered on May 6, and formal resistance in the Philippines ceased on May 9.

To the south and west, Japanese forces began occupying the East Indies in January and defeated Allied naval attempts to intervene. The Japanese wrested Malaya and Singapore from their British-Commonwealth garrison by February 15 and completed their conquest of the East Indies on March 9. Burma's Yenangyaung oil fields fell on April 18. Japanese leaders planned that when full production resumed from these newly acquired sources and all shipments reached the home islands, Japan would be self-sufficient in petroleum. After the Japanese overran Mandalay on May 1, British and Commonwealth forces, and a small group of Chinese and Americans, retreated across the Indian frontier, while most of the Kuomintang (Nationalist) units of Generalissimo Chiang Kai-shek (Jiang Jieshi) continued northeast toward Kunming. After raiding Darwin, on Australia's northern coast, aircraft from seven Japanese carriers struck bases and sank more than 30 Allied warships and merchant vessels in the eastern Indian Ocean and the Bay of Bengal early in April. The Imperial Army refused to provide troops, and so the Japanese task force did not invade Ceylon (now Sri Lanka), India, or Madagascar and left for Japan on April 8.

The U.S. Navy planned raids to try to keep the Japanese off balance. U.S. naval aircraft struck islands in the Gilbert (Tungaru in Kiribati) and Marshall groups, Wake, Rabaul, and bases on the north coast of New Guinea in February and March 1942. Two U.S. fleet carriers, commanded by Vice Admiral William F. Halsey, Jr., and carrying 16 B–25 Mitchell medium bombers of the U.S. Army Air Forces (USAAF), sortied from Pearl Harbor to strike Japan. On April 18, Halsey's task force encountered and sank a Japanese far-sea patrol. Although well east of their planned launch point, the B–25s and their 5-man crews, led by Lieutenant (Lt.) Colonel James H. Doolittle, immediately took off for Japan. Doolittle's raiders dropped their 1-ton bomb loads on industrial and military targets in southern Honshu—principally in the Tokyo-Yokohama area, but single planes struck Nagoya, Osaka, and Kobe—before flying on to China and rescue or capture.

Doolittle's raid, although tactically only another pinprick, lifted American morale and proved far more effective strategically than the shells and aircraft bombs from Japanese submarines that earlier slightly damaged oil facilities and forests on the California and Oregon coasts.[3] The danger of additional direct assaults on Japan and the continuing easy victories elsewhere encouraged the Japanese to

try to expand their barrier to include the western Aleutians, Midway Island, the Gilberts, Samoa, Fiji, the Solomons, all of New Guinea, and New Caledonia, whose chromite and nickel ores, and lesser deposits of cobalt, copper, gold, iron, lead, and silver General de Gaulle now controlled. The expansion was aimed at preventing future air attacks on the home islands, interdicting Allied supply lines to Australia and New Zealand, and luring the U.S. Pacific Fleet into the ever-sought decisive battle. Admiral Yamamoto's plan to achieve this victory, now approved, divided the Imperial Combined Fleet, including 8 of its 10 carriers, into 6 components to attack Midway, thought to be the Doolittle raiders' base, and, as a diversion, the Aleutians. The Combined Fleet planned to ambush the U.S. Pacific Fleet as it advanced from Hawaii to rescue Midway.

In the east, Axis forces renewed their assaults on Allied units in the Atlantic and Mediterranean and those on the African and Russian fronts. German submarines, while concentrating on U.S. oil tankers, bauxite freighters, and other new targets in the Western Atlantic, also continued to attack convoys sailing for Britain and northern Russia. U-boats destroyed these ships faster than replacements could be built. General Rommel and his Italo-German troops pushed the British and Commonwealth forces out of Libya and into Egypt. In May 1942, as British forces occupied Cyprus, the Wehrmacht resumed its offensive on the Eastern Front. As the Germans closed on Sevastopol late in June, Hitler ordered major forces shifted southeast to capture Rostov-on-Don and Stalingrad, interdict river transport on the Volga, and then push on to the Caucasus and the oil fields at Maikop and Grozny. Then they planned to continue toward the ultimate prizes, the Caspian oil fields around Baku and those of the Persian Gulf region, possible link-ups with Rommel and the Japanese, and perhaps an increased exchange of resources and technology between Germany and Japan. In July, Hitler ordered armored units transferred from the Caucasus forces to help those nearing Stalingrad.

By May 1942, the Axis Powers had significantly improved their mineral position, strengthened their capacity for war, and increased the Allies' raw-material problems.[4] As fiscal year 1941–42 ended, the U.S. Bureau of Mines (USBM) estimated that the Axis controlled 72 percent of the world's production of tin, 68 percent of its magnesium and mercury, 64 percent of its tungsten, and 54 percent of its aluminum. The USBM also predicted that the Germans, the Italians, the Japanese, and their allies might gain mastery over most of the globe's chromite and manganese ores. Axis control of the world's iron ore rose from 6 to 46 percent; steel capacity increased to 34 percent. Germany's earlier occupation of Czechoslovakia gave the Axis significant reserves of uranium ore, making it more or less independent of those in the Belgian Congo. The Axis Powers also nearly doubled their coal production (to 53 percent of the world's production), but, even with the new sources of petroleum captured by Japan, they only partly alleviated their most serious fuel shortage.

Allied responses included two significant meetings in Washington during the winter of 1941–42. At the Arcadia Conference that began on December 22, Roosevelt, Churchill, and their principal military advisers planned war strategy. On January 1, representatives of the United States, Britain, China, the Soviet Union, and 22 other countries signed the Declaration of the United Nations, based on the Atlantic Charter. The United States and Britain established a Combined Chiefs of Staff to plan and coordinate future operations, agreed that neither country would make a separate peace with the Axis, and declared that they would concentrate on defeating Axis forces in North Africa and Europe. The agreement reached at the secret talks, held in Washington during January 29–March 2, confirmed the "Germany-first" decision. Minimal Allied forces would contain Japan in the Pacific and Far East until military successes in Europe and North Africa, or increased Allied resources, or both, enabled stronger blows against the Empire. Joint boards were set up for munitions, raw materials (including a Combined Minerals Board),

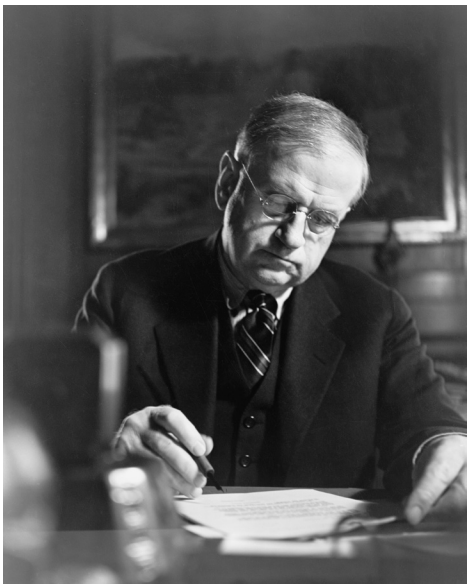
and food. They included representatives of the 6 Caribbean and Central American nations that declared war on the Axis after the Japanese attack on Pearl Harbor and the 19 other Latin American countries (but not Argentina and Chile) that broke diplomatic relations with Germany after the Inter-American Conference in Rio de Janeiro in January 1942 .

The U.S. Joint Chiefs of Staff (JCS), established by Roosevelt in February 1942, also aided the President to advance the U.S. war effort. Admiral William D. Leahy, who resigned as ambassador to Vichy France as part of the administration's protest of Vichy policies, chaired the new JCS. Leahy was joined by Army General George Marshall; Admiral Ernest King, Commander in Chief of the U.S. Fleet (COMINCH) and later also Chief of Naval Operations (CNO); and U.S. Army Air Forces' (USAAF) Lt. General Henry H. ("Hap") Arnold. Marshall, who continued to favor a Europe-first strategy, had earlier opposed basing the Pacific Fleet at Pearl Harbor. Roosevelt made the brilliant but irascible King, a former aviator and carrier commander, COMINCH on December 30, 1941. King selected Admiral Chester W. Nimitz, a submariner then Chief of the Bureau of Navigation, to lead the Pacific Fleet. From March 1942, Nimitz also headed the three-part Pacific Ocean Areas, a post equivalent to MacArthur's command of the Southwest Pacific Area. King and Nimitz favored defending an arc of U.S.-held islands from Midway to American Samoa and beginning limited offensives against the Japanese outer perimeter.

Winning the global conflict meant seeing production as the keystone of America's war effort. Roosevelt, in his State of the Union Address to Congress on January 6, 1942, called for greatly increased production of weapons and shipping, "far above present levels, even though it will mean the dislocation of the lives and occupations of millions of our own people." The President noted in his address that

> **[p]roduction for war is based on metals and raw materials—steel, copper, rubber, aluminum, zinc, tin. Greater and greater quantities of them will have to be diverted to war purposes. Civilian use of them will have to be cut further and still further—and, in many cases, completely eliminated.[5]**

In the Interior Department, the USBM and the USGS were involved in searches for strategic and critical minerals as part of the Nation's preparedness program. Meeting production goals required increased efforts to supply the necessary raw materials and energy. Secretary Harold Ickes placed all his bureaus and their employees "on a war-emergency basis"[6] and then ordered a workweek of 44 hours for Interior employees. Ickes established a War Resources Council on January 14, 1942,[7] and appointed to lead it Michael Straus, Ebert Burlew's successor as First Assistant Secretary. Ickes approved a war program to mobilize "the strategic natural resources of this Nation on the scale made necessary by global warfare" and supply the essential raw materials and power to industry "to attain the national war production goals set by the President." The War Resources Council gave priority to "metals for war" and noted that "years of exploration and experiment" prepared the USBM and the USGS "to move the country forward toward production on a victory scale by turning known but unused, low-grade materials into metals." The war program included carrying on "explorations for copper, lead, zinc, iron, chromite, aluminous clays, vanadium, tungsten, and mercury to the point of action,"[8] which involved the USGS but placed greater emphasis on the USBM's metallurgical investigations. Two Executive orders[9] enabled the Civil Service Commission to aid these efforts by making Federal appointments for the war's duration, and a maximum of 6 months thereafter, and approving war-service transfers between and within the departments and their agencies.



Harold LeClaire Ickes (1874–1952), the 32d Secretary of the Interior (1933–46), was educated at the University of Chicago and then practiced law in that city and reported for two of its newspapers. Also active in conservation and politics, he left the Republican Party in 1920 to support the Democrats' ticket of James Cox and Franklin Roosevelt. After backing FDR in the 1932 campaign, Ickes served the new President as Director of the Public Works Administration (1933–39) while he was Secretary of the Interior. Ickes, although a Roosevelt confidant, kept many of the New Dealers at a distance. During World War II, Ickes wore additional hats as head of the Petroleum Administration for War and the Solid Fuels Administration for War. After the war, Ickes strove for civilian management of the Trust Territory of the Pacific Islands. FDR repeatedly refused the self-styled curmudgeon's offers to resign to protest some of the President's policies or decisions. When Ickes tried the same tactic in opposing President Truman's nomination of Edwin Pauley as Under Secretary of the Navy in 1946, Truman quickly accepted Ickes' resignation. (Photograph from the Library of Congress, Prints and Photographs Division, 3c37622.)

The Interior Department remained the major producer of power in areas where the principal undeveloped resources were located. The Boulder (Hoover), Bonneville, and Grand Coulee Dams, completed during 1936–42, produced power annually at the rate of more than 7 billion kilowatt hours of electrical energy. Interior's program on power for war called for constructing new hydroelectric and steam plants to triple 1941's output by 1945. Neither the President, in his State of the Union Address, nor the War Resources Council showed concern about energy sources such as coal and petroleum because, when war began in Europe, shortages of these commodities in the United States seemed unlikely. Secretary Ickes acquired responsibility for petroleum and solid-fuels production before the attack on Pearl Harbor.[10] As Petroleum Coordinator for National Defense, Ickes synchronized Federal activities concerned with the production, refining, transportation, and marketing of petroleum and worked closely with industry in this endeavor. As Solid Fuels Coordinator for National Defense, he stressed orderly production, distribution, marketing, and consumption of coals and cokes to ensure adequate supplies at reasonable prices for military, industrial, and civilian needs. Interior's war program also provided for greater production of helium for use in blimps and weather balloons, increased water supplies for irrigation and military use, a food-drying program to save metals, aid to road building in Alaska, mapping areas of military significance, and clearing withdrawn public lands of mineral and other claims to enable the location and construction of military facilities.

Accomplishing the President's production goals remained a task less organized and more difficult. The first War Powers Act gave Roosevelt authority to redistribute "functions among executive agencies"[11] to enhance defense, prosecute the war successfully, increase support for the armed forces, effectively utilize resources and industries, and operate more efficiently as Commander in Chief. The Truman committee's report, sent to the Senate on January 15, 1942, criticized the Office of Production Management (OPM) as ineffective, making changes imperative. On January 16 and 24, Roosevelt's Executive orders established and amended the responsibilities of the War Production Board (WPB),[12] within the Office for Emergency Management (OEM). The WPB replaced two abolished agencies—the OPM and the Supply Priorities and Allocations Board (SPAB). The President picked Donald Nelson to chair the WPB, with Charles Leith as one of his advisers, but otherwise its seven members represented simply a reshuffling of the persons who comprised the OPM and the SPAB. Additional Executive orders through April 13 defined the WPB's duties to "obtain from foreign sources such materials, supplies, or commodities (other than arms, munitions, or weapons of war) as are necessary for the successful prosecution of the war, and provide for the production, delivery, sale, or other disposition thereof."[13] Roosevelt also gave Nelson the authority, under the National Defense Act of 1916, to place domestic orders, establish priorities for them, and take possession of plants that refused cooperation.

Those changes did not provide the desired result. Embarrassing shortages existed at home; by the summer of 1942, the most critical shortage remained the paucity of rubber. Neither adequate stockpiles nor a synthetic-rubber program existed because Donald Nelson failed to counter the view of Vice President and WPB member Henry Wallace that Latin America could supply all of the needed rubber. A lack of synchronization in producing parts also hampered the production of weapons of war. Even shortages of petroleum developed only a few months after America's entry into the conflict. Nelson also found himself clashing over war-production controls with Brehon Somervell, a Major General since January 1, who became head of the Army's Services of Supply on March 9. Robert Patterson, Under Secretary of War since December 1940 and responsible principally for procurement and production, represented Secretary Henry Stimson and the War Department on the WPB.

Henry Wallace remained as chairman when the Economic Defense Board (EDB) became the Board of Economic Warfare (BEW),[14] and the British ministry's twin, on December 17, 1941, adding yet another acronym to what was called Roosevelt's alphabet soup of agencies. In April 1942, the BEW received responsibility for obtaining the materials and commodities, other than arms, munitions, or weapons of war, needed to be imported either for the war-production effort or for the civilian economy. At the same time, Wallace's BEW also was tasked with carrying out certain duties under the Lend-Lease Act. These new responsibilities imposed difficulties. To procure the needed foreign materials, the BEW received authority to direct the creation, organization, and financing of a corporation or corporations to obtain materials and commodities from foreign sources but no funds of its own for this purpose. The BEW relied for monetary support on the Reconstruction Finance Corporation, headed by Secretary of Commerce Jesse H. Jones, whose fundamental economic philosophy opposed Wallace's views.[15] Jones led the RFC, which funded BEW projects, for some 7 years before succeeding Harry Hopkins as Commerce Secretary in 1940. To complicate matters even further, Jones also administered the Federal Loan Agency and served on the SPAB and the EDB. Duties assigned to the renamed BEW under the Lend-Lease Act also could have incited a conflict with the Department of State.

By June, Wallace's BEW organized a Metals and Minerals Division responsible for the procurement, development, and production of minerals required from countries abroad for war use. Alan M. Bateman, on leave from his position as Silliman Professor of Economic Geology at Yale, led the new Division. Bateman selected as his Associate Chief William E. Wrather, a successful independent petroleum geologist in Texas and, like his friend Everette DeGolyer, a history buff and ardent bibliophile. Bateman's Division, advised by William Heroy (Sr.) and others, initially was composed of six sections, those led by James S. Baker, Herman L. Dauth, Hugh E. McKinstry, Robert H. Ridgway, Paul M. Tyler, and William Warfield. On April 14, the BEW received the WPB's stocks of strategic and critical minerals. The BEW's responsibilities did not include coal or petroleum, still considered in adequate supply in the United States; those resources remained under Ickes' control as Congress considered the USGS budget for the coming fiscal year.

The Roosevelt administration prepared its budget for fiscal year 1942–43 before the Pearl Harbor attack and only hastily and partly revised it before the President sent his annual message to Congress in January 1942. The budget anticipated expenditures of $56 billion during fiscal 1942–43, more than the Nation's estimated annual income, and called for increasing the national debt. The accompanying budget provided for only $13.6 billion; the rest would follow in supplemental requests. For the USGS, Interior originally asked for nearly $7,644,000, an increase of 55 percent above the appropriation approved in June 1941. The Bureau of the Budget trimmed this amount to about $3,753,000, 24 percent less than the sum appropriated in June 1941, and eliminated all funds for strategic mapping because the War Department's allocation of $1.75 million for that purpose would remain available until June 30, 1943.

The initial supplemental request did not reach Congress until March 23, 1942, after the House Committee on Appropriations finished its work on Interior's funding bill. The Senate Committee on Appropriations considered the first supplemental request but received others before it filed its report. The committee recommended, and the Senate passed without debate, significant increases in funding for geologic surveys, studies of strategic and critical minerals, and work on Alaska's mineral resources. The conference committee reduced the total provided by only $36,000. Not until July 2, a day after the new fiscal year began, did Roosevelt sign the bill that provided the USGS with direct funds of some $4,691,000 for its work during fiscal year 1942–43.[16] The new law also gave $498,500 to the USBM, of which $80,000 would be transferred to the USGS.[17] Deficiency and supplemental

legislation enacted in 1943 raised the USBM-derived monies to $115,000 and gave the USGS a credit of $400,000, pending reimbursement from cooperating agencies. Funds received from other sources raised the total funds available to the USGS in fiscal 1942–43 to more than $11 million, larger than any single-year sum previously received. For the first time in many years, the Geologic Branch received the greatest share of the new monies and almost doubled those provided in fiscal 1941–42. Major changes in the USGS began as soon as it received those funds. Fiscal 1941–42 was nearly half over when the United States entered the war, and the field season of 1941 was long past. The appropriation of $150,000 for strategic-minerals investigations and the War Department's transfer of funds for strategic mapping made a difference in parts of the Geologic, Alaskan, and Topographic Branches, but otherwise the field season resembled that of 1940.

During fiscal year 1942–43, the Geologic Branch received nearly $1,916,000 from all sources and underwent significant changes in organization, staffing, and operations. Although its personnel maintained their interests in fundamental research through close cooperation with some of the States, professional societies, and the National Research Council, especially on studies that might prove useful to the war program, they were fully committed to supporting the effort to win the conflict. Additional funds enabled the Branch to increase its professional staff from some 150 to more than 280 persons by hiring mostly from academia and industry. Chief Geologist Gerald Loughlin gained the aid, from February 1942, of new Assistant Chief Geologist Stephen Capps, a long-term veteran of work in Alaska and on manganese and other mineral deposits in the Western States and in Brazil. To facilitate cooperation with the USBM, the Geologic Branch established regional offices in College Park, Maryland; Rolla, Missouri; Salt Lake City, Utah; and Spokane, Washington. The Branch's Section of Geophysics, which came to the USGS in 1936, returned to the USBM on October 5, 1942. Secretary Ickes believed the Section's services in the USBM would "locate critical minerals more quickly," "prevent useless drillings," and "speed its exploratory work." USGS funds were "inadequate to do such geophysical work as the Bureau of Mines considers necessary,"[18] and the combined efforts also would increase economy and efficiency. Ickes expected USBM reports to meet USGS needs for geophysical work.

To prepare "terrain intelligence studies" of strategic areas for the Army Engineers, under "wartime priorities,"[19] the Geologic Branch founded an informal and then a formal Military Geology Unit (MGU) in 1942. German and Soviet forces entered their war with large numbers of specialists in terrain intelligence already on their rolls, some of whom served in World War I. In 1937, Ernst Kraus began organizing what became 2 years later the 10th Group, Technical Military Geology, of the German Army Ordnance's Engineer and Fortress Department. Organized by function into six subdivisions and two working subgroups, members of Group 10 used books on military geology by Erich Wasmund (1937) and by Kurd von Bülow, Walter Kranz, and Erich Sonne (1938) as references in training new personnel. They also tested equipment, conducted experiments, deployed field-force teams to the various combat fronts to gather data on the ground, and compiled geologic-tectonic, water-supply, and construction-materials reports and maps at scales from 1:25,000 to 1:100,000. After Kraus retired in December 1941, Bülow took command of the central unit in Berlin.[20] Group 4 of the German Army General Staff's Department of War Maps and Surveys included additional military geologists. Other geologists served in the Kriegsmarine, the Luftwaffe, the Waffen-SS, and the paramilitary construction organization run by Fritz Todt and (later) Albert Speer as ministers of armaments and munitions.

During the interwar years, the USGS failed to build significantly on its own legacy of military geology from World War I. Alfred H. Brooks took leave as head

of the Division of Alaskan Mineral Resources to lead a requested effort in military geology for General Pershing's American Expeditionary Force (AEF) in France. In 1917, Major (later Lt. Colonel) Brooks and Captain (later Major) Edwin C. Eckel, who left the USGS in 1906 to become a private consultant,[21] were commissioned in the Engineer Officers Reserve Corps. In September 1917, they established a Section of Geology attached to Pershing's headquarters. Brooks, as the AEF's Chief Geologist, operated within the AEF's Division of Front Line Engineering, then was in the AEF's Division of Engineering Intelligence, and finally reported to the Assistant to the AEF's Chief Engineer. Brooks' unit supplied information and advice about the soils and rocks encountered by the AEF in mining operations and in building and maintaining trench systems and other fortifications, constructing roads and railroads, and seeking supplies of potable water.

In July 1918, the AEF approved Brooks' plan to have six geologist-officers with him at Pershing's headquarters, place five more with each U.S. army, and assign two others for work along the lines of communication. The war ended in November before Brooks could fill all of these slots. At the Armistice, Brooks led a unit that included Eckel and USGS geologist Kirk Bryan, a Yale-trained scientist commissioned as 2d Lieutenant after being relieved from his assignment as a Private of Army Engineers and draftsman in France. Four men served with Brooks at AEF Headquarters, two with the 1st Army, one with the 2d Army, and one with the Water Supply Section.[22] Brooks returned to the United States in August 1919 and promptly published his analysis of how the AEF used geology, but he died in 1924 before recording the details of how he established his geology unit. He recommended that geology be included in military training, suggested peacetime collection of geologic information about potential theaters of war, and proposed organizing a "staff of geologic engineer reserve officers."[23] Thomas Nolan was among the few USGS geologists who held reserve commissions in the Army Engineers between the wars, but his lieutenancy lapsed in 1937 after a 5-year interval of no service.

After the Japanese attacked Pearl Harbor, several USGS geologists quickly sought to revive the agency's earlier efforts in military geology, using existing and new contacts. They and other members of the Geological Society of America convened in Boston, on December 29, 1941, for the GSAm's 54th annual meeting, determined to contribute to the war effort as they had done for aspects of prewar national defense. Existing GSAm pamphlets included Leith's on strategic minerals, Douglas W. Johnson's on geology and strategy in the present war, and Walter H. Bucher's bibliography of military geology and geography.[24] GSAm pamphlets underway involved Sidney Paige's view of engineering geology in war, Johnson's discussion of geology's role in World War I, and William O. Hotchkiss' description of the Army Specialist Corps.[25] Hotchkiss, as a Brigadier General, served as the Army Specialist Corps' Deputy Director during June–December 1942. The GSAm continued contributing to the National Roster of Scientific and Specialized Personnel and asked the Selective Service System to list geology as a critical occupation.

Director Walter Mendenhall led the USGS delegation of full- and part-time employees to the GSAm's meeting in Boston. These participants included Chief Geologist Loughlin, Kirk Bryan and Esper Larsen, Jr. (Harvard), Julia A. Gardner, Chester Longwell (Yale), Thomas Nolan, Clarence S. Ross, William W. Rubey, and Parker Trask. Also attending were the BEW's Alan Bateman and Hugh McKinstry, the Petroleum Administration for Defense's (PAD's) Everette DeGolyer and William Heroy, and Sidney Paige, the principal geologist of the Army Engineers' North Atlantic District since 1935, who previously had worked for the USGS and an energy company (Amerada, later Hess). Longwell was elected one of the GSAm's four vice presidents for 1942. The GSAm's nine-member Council included Bryan, DeGolyer, Hotchkiss, and Rubey. Rubey and DeGolyer also served, respectively, on the GSAm's Committee on Research Program and its Subcommittee on

William Walden Rubey (1898–1974) joined the USGS in 1920 and briefly worked on the geology of oil and gas occurrences before shifting to studies in general geology. Rubey, on a 6-month detail from the strategic-mineral program during part of 1941–42, arranged the USGS effort in military geology, funded by the Army Corps of Engineers. In postwar years, Rubey advised USGS and other administrators while also investigating topics in basic and applied science that included stream hydraulics and sedimentation, the geology of seawater, and (with King Hubbert) overthrust-fault mechanics. (Photograph from Gilluly, 1977.)

Geophysics; the subcommittee also included M. King Hubbert, who left Columbia in 1940, the same year that he published his theory of groundwater motion and its influence on hydrocarbon accumulation. Trask and USGS geologist Harry S. Ladd were members of the GSAm's Subcommittee on Ocean Bottoms.

Reginald A. Daly, Sturgis-Hooper Professor of Geology at Harvard and Penrose Medalist in 1935, welcomed attendees as being "in the front line of National Defense." "In this total war, as in the total peace that must come after it," he emphasized, "geology, the science of raw materials, is at the very root of the matter."

> **The world is hungry for iron, aluminum, copper, chromium, magnesium, beryllium, tungsten, salt, sulphur, potash, phosphate, and petroleum, and therefore hungry for your techniques in finding these things. They are needed both for winning the war and for winning the peace that can only be assured by filling the world's belly.[26]**

On December 30, 1941, the GSAm's Council appointed a Committee on War Effort, comprising Chairman Hotchkiss, former USGS geologist Kenneth C. Heald, Longwell, and Rubey. The new Committee promptly prepared a resolution, adopted unanimously on the following day, requesting the GSAm to "pledge its best efforts, collectively and individually, to meet all calls that may be made upon it and its members for whatever services geology and geologists can provide," especially in research and beyond those activities already underway, and to emphasize studies that "will most effectively contribute to victory."[27] The Committee also asked the Council "to present the resolution to the proper authorities and to offer all possible aid of the Society and its membership to our Government."[28]

Loughlin wished to limit USGS war-related work to the ongoing investigations of strategic minerals, but Mendenhall disagreed and authorized wider participation. Nolan could not be spared from his supervisory work for Hewett's program. On January 2, 1942, Mendenhall and Loughlin relieved Rubey of his own strategic-mineral responsibilities for 6 months so that he could promote a greater use of geology and geologists during the war. Rubey promptly contacted many Army and Navy organizations, 10 of which showed "some degree of serious interest with regard to the services geologists can offer."[29] Members of the Army's General Staff and the staff of Secretary of War Henry Stimson referred Rubey to the Army Engineers.

On January 6, Rubey talked with Colonel William F. Tompkins, who met Brooks in France, served as an Executive Assistant to General Schley in 1940–41, and now worked at the Army War College. After reading Rubey's brief outline of the potential uses of military geology, Tompkins recommended distributing a more formal version to gain approval for two principal geologic activities: "(1) to accompany units such as his own after they had been assigned to specific theaters of operation and (2) to participate at Engineer headquarters in Washington in the compilation and analysis of data for strategic planning."[30] Responding to Tompkins' suggestions, Loughlin appointed USGS geologists Wilmot H. ("Bill") Bradley, Edwin B. Eckel, Charles Hunt, Rubey, and Trask as a special committee to revise Rubey's outline. On January 8, the USGS distributed its special committee's revision to officers in the armed forces and managers in civilian agencies. After additional review by the GSAm's Committee on War Effort, the utilization outline appeared in February; its print run exceeded 10,000 copies by year's end.[31]

On January 12, 1942, Rubey visited Major General Eugene Reybold, General Schley's successor as Chief of Army Engineers since October 1941, to discuss the USGS outline. General Reybold "readily agreed" to approve "any requests for field geologists that came to him from the Chief Engineers of task or expeditionary forces * * * but he emphasized that such requests could not originate in that office." Reybold, briefed by Hotchkiss 2 days earlier, expressed special interest in using "geologists for engineering intelligence and staff planning in the Washington office."[32]

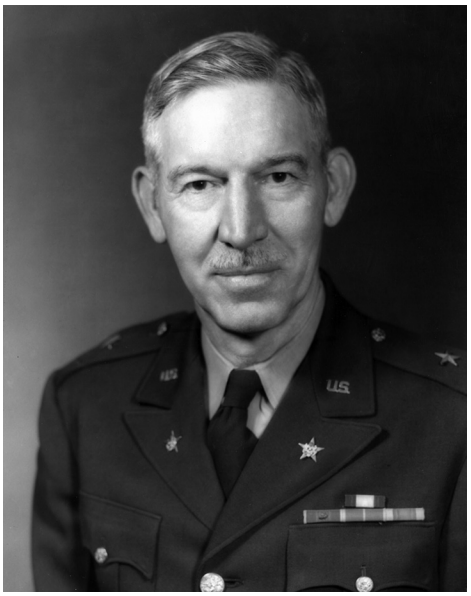
Schley introduced Rubey to Lt. Colonel (later Colonel) Herbert B. Loper, a photogrammetrist and Chief of the Intelligence Division in Reybold's office since July 1940, and asked them to plan to gain this aid.

General Reybold's subsequent letter to Hotchkiss, and Rubey's conference with Lt. Colonel Loper on January 14, revealed the Army Engineers' wishes. They wanted to add the USGS to their strategic-intelligence assets directly and not through the GSAm. The Engineers did not want a uniformed unit like Brooks' Section of Geology in World War I, nor could they find space for any additional geologists in their already crowded offices. Rubey, emphasizing the nationwide scope of the GSAm's resolution, suggested that the best qualified geologists be gathered in Washington as a temporary team of consultants and housed near the USGS Library, where they would have to work. Loper doubted that they could be assembled quickly given the demands of secrecy and time. Engineering intelligence, he thought, could be produced best by "a permanent corps of specially qualified experts who were cleared to work on secret projects under the aegis of some regularly constituted civilian Government agency such as the U.S. Geological Survey." Rubey then agreed to work out "whatever arrangement would best meet the demands of the War Department," and Loper promised to provide "the types of information that geologists would be expected to supply" and a "concrete plan by which this information could be supplied to the Corps of Engineers."[33]

Lt. Colonel Loper asked Major Paul W. Thompson, Chief of the Strategic Intelligence Branch in Loper's Division, to review Rubey's preliminary proposal. While Major Thompson evaluated Rubey's concept, the GSAm Committee on War Effort encouraged Ernst Cloos, a geologist at Johns Hopkins University (JHU), to volunteer to prepare summaries and reviews of recent German publications on military geology. Rubey edited the 20-plus drafts by Cloos and sent them to the Army Engineers, to other Federal agencies, and to the GSAm for distribution to some of its members. Cloos' comments helped to convince Major Thompson that improved engineering intelligence required active participation by geologists. General Reybold's office staff began translating the volumes by Wasmund and by Bülow, Kranz, and Sonne. Thompson, accompanied by two of the Army Engineers' assistants, geologist Mark P. Connaughton and civil engineer John R. Vogler, visited the USGS to work out an agreement between the two agencies.

On February 20, 1942, Thompson, now a Lt. Colonel, asked Director Mendenhall to select USGS geologists to prepare within 1 week a report on the "building materials, soil, water, and fuel supplies of certain parts in northwest Africa,"[34] similar to those the agency completed about strategic minerals earlier that month on equally short notice from the BEW and the Army. At 2 p.m. on February 11, as Paul Averitt and Lincoln Page later recalled, some "big wheel" in the Army asked the USGS to complete by 5 p.m. the next day a report on all of Africa's mineral resources. Told to pick one country, the Army official chose Sierra Leone, because it was a British colony with its own Geological Department quartered near Freetown's growing air and naval bases, and so the report could be checked more easily than one about Vichy Algeria, Morocco, or Senegal.

As Rubey later related, Edwin B. Eckel took command of the operation. Mendenhall was not expected back from the meeting in New York of the American Institute of Mining and Metallurgical Engineers (AIMME) until some 2 hours before the deadline. Eckel asked Ward Smith to get all the reports mentioning Sierra Leone from the Library. Paul Averitt, Bill Bradley, James McAllister, and Lincoln Page gathered in Eckel's and Edwin Goddard's offices and worked from 4 p.m. to 2 a.m. on the 11th and then returned from 8 a.m. to 3 p.m. the next day. Eckel scanned the sources Smith brought and passed them to the person responsible for the specific mineral-commodity group. Each geologist reduced that information to one paragraph, written informally, and gave it to Page, who placed the paragraphs in an outline and drew the preliminary maps. Bradley provided data on surficial and



Herbert Bernard Loper (1896–1989), a photogrammetrist educated at West Point and the Massachusetts Institute of Technology, served in the U.S. Army from 2d Lieutenant (1918) to Major General (1952). In 1942, Lt. Colonel (later Colonel) Loper, then Chief of the Intelligence Division in the Office of the Chief of Engineers, helped the USGS to establish a Military Geology Unit (MGU) and also signed the Loper-Hotine Agreement that divided responsibilities for global mapping between the United States and the United Kingdom. During 1944–45, Brigadier General Loper supervised MGU field teams while serving as Chief Engineer of Army Forces in the Pacific Ocean Areas, then as Chief of Engineer Intelligence in the Southwest Pacific Area, and lastly as Deputy Engineer, Far East Command in Japan. During the war, Loper earned a Legion of Merit and a Distinguished Service Medal. In postwar years (until 1948), he served again as Chief of the Intelligence Division, Office of the Chief of Engineers in Washington, D.C. Loper then filled two staff positions relating to intelligence and atomic energy (1948–51) and led the Armed Forces Special Weapons Project (1951–55) and chaired the Military Liaison Commission to the U.S. Atomic Energy Commission. After retiring in 1955, he joined the group of scientists and engineers who advised USGS Directors Wrather and Nolan. (U.S. Army photograph, December 15, 1950; from the U.S. Army Corps of Engineers, Office of History.)

sedimentary materials, and A. Nelson Sayre contributed information on hydrology. After a typist from one of the mineral deposits sections completed the text, Eckel and Page read it through for the first time in the Director's outer office. All of these specialists drew on their training in report writing from Henry Ferguson and Frank Calkins, and so their report read as though one person wrote it. At 4 p.m. on the 12th, Mendenhall approved unread the 18-page report and its sketch map. Eckel took a cab to deliver the report by 5 p.m. to the Army's waiting plane. Thereafter, Mendenhall spent 2 hours with Eckel's team. The Director thanked the participants for their initiative in recognizing the need for the USGS to do this work for the war effort, discussed their current research, and told tales about his early fieldwork.

The Sierra Leone report proved to be one of many strategic-intelligence studies and related medium- and small-scale reports about other countries worldwide completed for the Army Engineers by a small group of USGS scientists and supporting staff led by Bradley, whose new team included Henry Ferguson and Hunt. Early in March, Lt. Colonel Thompson returned to the USGS with additional requests for: "(1) reports on the physical features and mineral resources (including groundwater) of a half-dozen or so countries in northwestern Africa and (2) a roster of American geologists who were especially well qualified in engineering geology, construction materials, and/or physiography."[35] The Army Engineers planned to commission at least 20 of these men and assign them to field duty, where each geologist-officer would work in a triplet including an Engineer officer and a forestry specialist "under circumstances of great responsibility and danger."[36] On March 28, Mendenhall appointed Bradley, Longwell, Rubey, hydrologist David Thompson, and stratigraphic-paleontologist Wendell Woodring as a special committee to prepare the roster. Although these men completed and later revised the list, the Army Engineers made no formal use of it and dropped the idea of forming the triplet field teams.

Rubey, and then Edwin B. Eckel, led the informal groups of USGS geologists, spared part-time from other urgent war work, in preparing for the Army Engineers the reports they requested about countries in northwestern Africa. By mid-March 1942, additional queries from General Reybold's office increased significantly the total number of reports prepared or underway. Rubey and his colleagues realized that if the Army Engineers did not establish a nationwide corps of geological specialists, the USGS would have to form a unit of full-time geologists to handle the growing demand for engineering intelligence. Loughlin, although still reluctant to transfer members of the Geologic Branch from the ever-increasing work on strategic and critical minerals, agreed late in March to release Bradley from his principal duties to lead the agency's new effort in engineering intelligence.

As Bradley began to select USGS colleagues for these studies, Hunt saw Cloos' review of Erich Sonne's 1936 article on military geological maps. Sonne's six plates included geologic, groundwater and mining, water-supply, and building-materials maps of an unidentified (and hypothetical?) 1:25,000 quadrangle located mostly north of a Glons River. Color-symbol charts provided detailed applied information about each of these four maps. Sonne's text and plates, with a standard stratigraphic section, reappeared in 1938 in the volume by Bülow, Kranz, and Sonne. Using Sonne's method of presentation, Hunt and his USGS colleagues prepared a series of demonstration terrain-intelligence maps of quadrangles in Arizona and Morocco, where Hunt once lived with his parents.[37] Lt. Colonel Thompson looked at their maps, gave them his "enthusiastic approval," authorized a translation of Sonne's text and captions, and asked the USGS to "cast its future reports, so far as possible, into maps following the patterns suggested by Sonne and Hunt." From these original formats and subsequent modifications, the USGS developed the "map-and-tabular-summary type"[38] that the agency used in presenting its military geology reports.

The Geologic Branch then founded an informal unit to supply the Army Engineers with terrain-intelligence studies at scales smaller than 1:100,000. Bradley and Hunt led the way in organizing the Military Geology Unit and proving its worth after Rubey returned to his strategic-minerals investigations. The MGU initially comprised a dozen persons, including geologists Carle Dane, Henry Ferguson, Marcus I. Goldman, and Kenneth E. Lohman, and hydrologist Nelson Sayre. The unit rapidly completed for the Army Engineers a number of intelligence reports, including two on Vichy French Madagascar. The initial report, with maps at several scales, covered that island's construction materials, geology, landslides, minerals, soils, terrain, vegetation, and water supplies. The second report, the first of the MGU's terrain-intelligence folios, also evaluated cross-country movement in and other aspects of the Diégo Suarez area (at 1:200,000) and its air-naval base at Antsirane (Antsiranana) on Madagascar's northern tip. The MGU finished its Madagascar studies just after May 5, 1942. On that day, British forces (in Operation Ironclad) invaded and occupied Diégo Suarez. Subsequent attacks on British ships in the port or at sea by Japanese midget and fleet submarines and auxiliary cruisers convinced the British and South Africans on August 11 to capture the whole island to help clear the vital sea lanes to the Middle and Far East.[39] After July 1, the MGU completed a comprehensive terrain-intelligence folio about Madagascar, Strategic Engineering Study (SES) 40, at 1:3,000,000, which the British reviewed and lauded. The remaining Vichy French forces on Madagascar surrendered on November 5; the island and its high-grade graphite, bauxite, coal, and chromite deposits passed to the Free French on January 8, 1943.

Those reports convinced the Army Engineers that library-based studies could supply useful analyses of terrain, engineering concerns, geology, minerals, and soils. Lt. Colonel Loper requested evaluations of an additional 75 areas, including Denmark, Java, New Caledonia, Guadalcanal and other islands in the Solomons, the New Hebrides (Vanuatu), and the Bismarck Archipelago (especially New Britain). On May 9, 1942, Loper formally asked for a report on terrain, construction materials, and water supply for the West and Northwest African ports of Bathurst (Banjul, Gambia) and Dakar in Senegal, Port-Étienne (Nouâdhibou) in Mauritania, and Agadir in Morocco. The USGS informal military geology unit delivered its summary on June 1. Other reports followed after July 1 for the whole of Morocco (and its Agadir, Chichaoua, Mogador, and Oued Tensift quadrangles), Algeria, Tunisia, and Libya. The Army Engineers sent copies to the headquarters that began planning in August for Operation Torch, the Allied invasion of Morocco and Algeria, led by Lt. General Dwight D. ("Ike") Eisenhower. These analyses were checked against aerial photographs available in September. After Torch's success in November, the U.S. Army forces' chief engineer and General Reybold commended the USGS reports. In May, Loper also signed the Loper-Hotine Agreement, an Anglo-American understanding "to divide mapping responsibility throughout the world. The British [Military Surveys, directed since 1941 by photogrammetrist and Brigadier Martin Hotine, Royal Engineers] agreed to take care of most of Western Europe and the Middle East [and Africa], leaving North and South America, the Far East, and the Pacific to the Americans."[40]

The USGS Military Geology Unit (MGU) began official operations as a formal unit on June 24, 1942, with Bradley as Chief and Hunt as Assistant Chief, and its members began applying their expertise without any additional training. Like the Beach Erosion Board's Foreign Section, the Board of Engineers for Rivers and Harbors' Foreign Ports Section, and the Engineer Research Office of the Army Engineer's North Atlantic Division in New York City, the MGU provided information and analyses to the Army Engineers' Strategic Intelligence Branch, the Joint Army-Navy Intelligence Staff, and the theater commanders. Connaughton, who led terrain studies in Lt. Colonel Thompson's Branch, provided liaison with the MGU.

Wilmot Hyde ("Bill") Bradley (1899–1979) began full-time work with the USGS in 1922 and concentrated on the varved strata, fossils, and paleoenvironments of the Green River Formation (Eocene) in Colorado, Utah, and Wyoming. In 1942, Bradley formed the USGS Military Geology Unit and directed its strategic and tactical engineering studies until he became Chief Geologist in 1944. Bradley, in reorganizing the Geologic Branch (later Division), appointed a new generation of Division (later Branch) Chiefs. Bradley returned in 1959 to full-time research on past and present algal-ooze lakes and their cyclical sediments as freshwater equivalents of the Green River playa-lake strata. (Photograph from the USGS Denver Library Photographic Collection, Portraits, in the "Last Name A–B" folder; published in *The American Journal of Science* Bradley Volume, 1960, portrait facing p. 1, and in Nelson, C.M., and Rose, E.P.F., 2012, fig. 2.)

In September, Mendenhall and the Acting Chief of Engineers signed a cooperative agreement, approved early in October by Interior's Assistant Secretary Oscar Chapman and by Secretary Stimson's representative for the War Department. The agreement, effective October 26,[41] authorized transferring up to $30,000 in Army Engineer funds during fiscal year 1942–43 (and additional monies as required in fiscal 1943–44) to add to USGS funds available to prepare the strategic-intelligence reports of areas specified by the Engineers. The MGU's staff of scientists, engineers, and supporting personnel grew larger and more diverse. Each scientific specialist was required to read effectively at least two foreign languages so the unit could expand coverage of scientific literature that came to include Chinese, Japanese, and Russian sources. Ferguson served as the MGU's "elder statesman and counselor."[42] He also compiled notes on aspects of airfield sites in northern Canada, the Canadian Archipelago, and eastern Greenland. Marie L. Siegrist coordinated work by the unit's librarian-bibliographers, and Kenneth Lohman managed its illustrations group.

For the Army Engineers during 1942, the MGU completed more than 30 unnumbered SES reports on Africa and its countries, colonies, protectorates, and offshore islands (Bonham and Leith, 1997). The unit's more than 20 numbered SES reports included terrain analyses for Alaska, Algeria, Angola, the Aralo-Caspian region, Belgium, the Caucasus, the mineral-rich Belgian Congo, Denmark, Egypt and Sinai, French West Africa, Iran, Iraq, Kamchatka, the Kuril Islands, the Levant countries (Lebanon and Syria), Morocco, Palestine and Transjordan, Italy's Pantelleria Island (in the channel between Sicily and Africa), Río de Oro (southern Spanish Sahara, now in Morocco's Western Sahara), Sardinia, eastern Siberia, and Tunisia. The MGU also prepared miscellaneous papers on coal and coke requirements for producing nickel in Vichy French New Caledonia, causing eruptions by bombing Japanese volcanoes, Sicily (by Marcus Goldman), bauxite reserves in British Guiana (Guyana) and Dutch Guiana (Suriname), and the geology of Vieques, the island east of Puerto Rico used for gunnery training by the Navy (by Eugene Callaghan).[43]

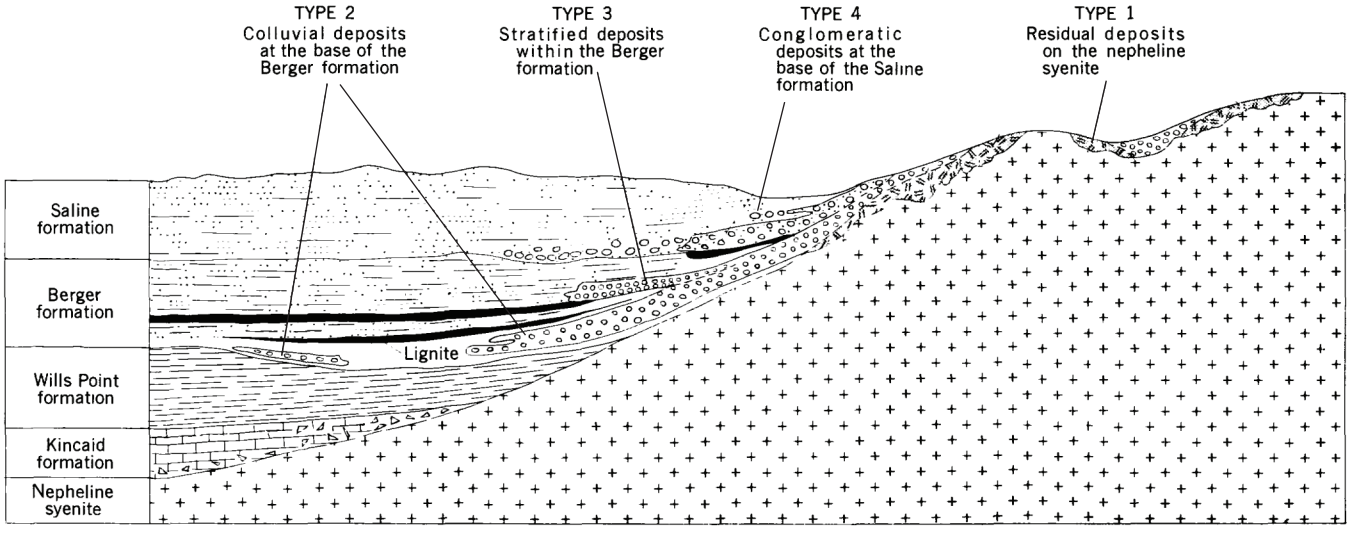
The Geologic Branch's field program in 1942 largely involved the continuing search for minerals needed for war production. Direct appropriations and other funds received for fiscal year 1942–43 raised the sum available for geologic surveys to about $1,175,000, nearly twice the amount the Branch received the previous year. Monies for studies of strategic and critical minerals rose to $741,000, 2.5 times the past year's amount. Chief Geologist Loughlin refined the structure of the war-minerals program on August 29, 1942. He appointed four Regional Geologists—Hugh Miser, later Josiah Bridge, at College Park; Harry Ladd at Rolla; Samuel Lasky at Salt Lake City; and Philip J. Shenon at Spokane—and made each responsible for overseeing operations in four or more States and for facilitating "cooperation between the Geological Survey and Bureau of Mines."[44]

Loughlin also appointed 21 Commodity Geologists. Under the general direction of the Section Chiefs, who would correlate the different commodity programs, each Commodity Geologist would direct the field geologists' work and help the Regional Geologists and the Washington staff "to assemble and make a permanent digest of the records and reports now on file."[45] The Commodity Geologists included Wilbur Burbank for molybdenum, arsenic, and other minor metals; Ralph S. Cannon, Jr., for copper; Edwin B. Eckel for mercury, with Paul Averitt as alternate; Richard Fischer for vanadium; Thomas Hendricks for manganese; Edwin T. McKnight for lead and zinc; Thomas Nolan for tungsten; William Pecora for nickel; Joe Peoples for chromium, with Thomas Thayer as alternate; Ward Smith for tin and pegmatite minerals; John Vhay for cobalt; Donald White for antimony; Arthur Baker for oil, gas, coal, helium, asphalt, and oil shale; Ernest Burchard for bauxite and bauxitic clay, with Watson Monroe as alternate; Edwin Goddard for

fluorspar, with James Williams as alternate; Thomas Lovering for iron ore, with Charles Park as alternate; Victor T. Allen for high-alumina clay; Eugene Callaghan for magnesium sources (except saline sources) and alunite; Hoyt S. Gale for saline deposits; Louis W. Currier for graphite and related nonmetals; and George Mansfield for phosphate, potash, and related nonmetals.

The Geologic Branch's scientists concentrated on studies of manganese, chromite, tungsten, and mercury. Branch geologists completed investigations of manganese in California, eastern Tennessee, and the Batesville district of Arkansas, and similar studies continued in 18 other States. Harold James and other geologists examined more than 100 chromite deposits in California, Georgia, Oregon, and Montana, most of them in cooperation with the USBM. In the Western States, Richard H. Jahns and other Branch specialists evaluated more than 100 separate tungsten areas and more than twice that number of individual deposits. Work also continued on domestic deposits of mercury; by the end of the year, most of the important producing areas were mapped in detail. The studies disclosed new ore reserves of mercury, notably at New Idria, California.

Geologic Branch geologists also continued investigations of iron, aluminum, and other minerals begun in 1940. In a project reminiscent of USGS-Tenth Census cooperative studies in 1879–81, as arranged and cofunded by Director Clarence King and led by Raphael Pumpelly, USGS geologists examined iron deposits in 22 States, giving particular attention to finding readily accessible reserves of direct-shipment lump ores of low-phosphorus content. Coworkers, in searching for raw materials from which aluminum and magnesium might be extracted, mapped in detail bauxite deposits in Alabama, Arkansas, Georgia, Mississippi, and Tennessee. Geologists found no large deposits of commercial-grade bauxite in the Appalachian region. Arkansas, once second only to France's Var district in producing bauxite ore, earlier yielded more than the other principal sources in Dutch Guiana (Suriname), western Hungary, British Guiana (Guyana), Yugoslavia's Istria district, France's Herault district, and U.S. localities in Georgia and Alabama. Field parties of the USGS Arkansas Bauxite Project, staffed by Robert P. Bryson, Mackenzie Gordon, Jr., Joshua I. Tracey, Jr., William E. Benson, and other Geologic Branch scientists, discovered many new deposits and recommended the most promising of them to the USBM for surveying and appraisal. The USBM began its Project 1101, an examination of some 1,500 square miles, with magnetic and gravity surveys, late in 1941; core-drill appraisals and developmental drilling followed early in 1942. These efforts located 900,000 tons of commercial aluminum ore in the Gulf of

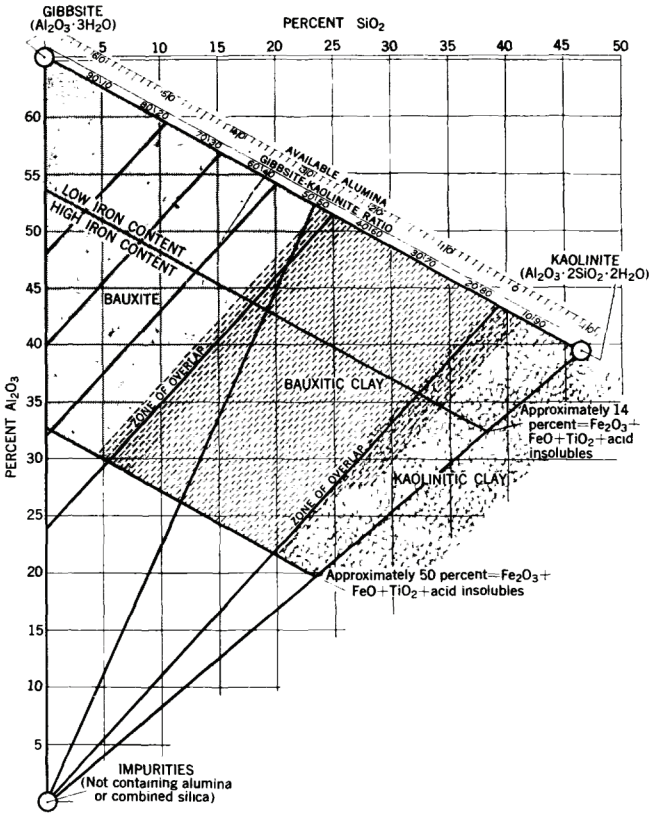


This diagrammatic section shows the four generic types—residual, colluvial, stratified, and conglomeratic—of bauxite deposits in the rocks of the Wilcox Group's Berger and Saline Formations (Eocene) in the Arkansas bauxite district. Wartime searches by USGS geologists located several new domestic sources of bauxite and other aluminum-bearing deposits. (From Gordon, Tracey, and Ellis, 1958, fig. 33.)

Mexico Coastal Plain and more than 3.5 million tons in 20 sites in Arkansas, in addition to the earlier discovered reserves. Greatly expanded studies of copper, lead, and zinc deposits concentrated on districts having large production, but geologists also examined minor deposits that offered possibilities of increased yields.

As the production of steel, aluminum, 100-octane gasoline for military aircraft, and other war material greatly increased the demand for fluorspar, the War Production Board asked the USGS to plan a comprehensive investigation of these deposits in the United States. USGS geologists searched for domestic fluorspar in cooperation with geologists and engineers from other Federal and State agencies and with local producers. Other specialists completed detailed geologic mapping in many localities and recommended the drilling of, or other exploratory work on, the most promising prospects. They found additional reserves in Colorado, New Mexico, Utah, other Western States, and the Kentucky-Illinois field, the supplier for many years before World War II of more than 90 percent of U.S. fluorspar requirements.

Geologic Branch specialists also examined additional mineral resources, including a special survey of possible new sources of cobalt and molybdenum in the Western States, Arkansas, Maine, New Hampshire, North Carolina, and Wisconsin. Their continuing investigations of vanadium centered on deposits on the Colorado Plateau, extending work begun there in 1939, and those in Idaho and Wyoming. In cooperation with the USBM and the war agencies, USGS geologists made substantial progress in estimating reserves of vanadium ore and recommending specific diamond-drilling programs in the geologically favorable areas. Quartz crystals, used in radio-communication equipment, were largely imported before the war; to meet increased demand, the USGS began searches for domestic deposits and located in Arkansas a modest supply of fine-quality crystals. The agency's geologists also examined deposits of arsenic, bismuth, graphite, strontium, and talc. In addition, they made in 16 States general and detailed assessments of pegmatite



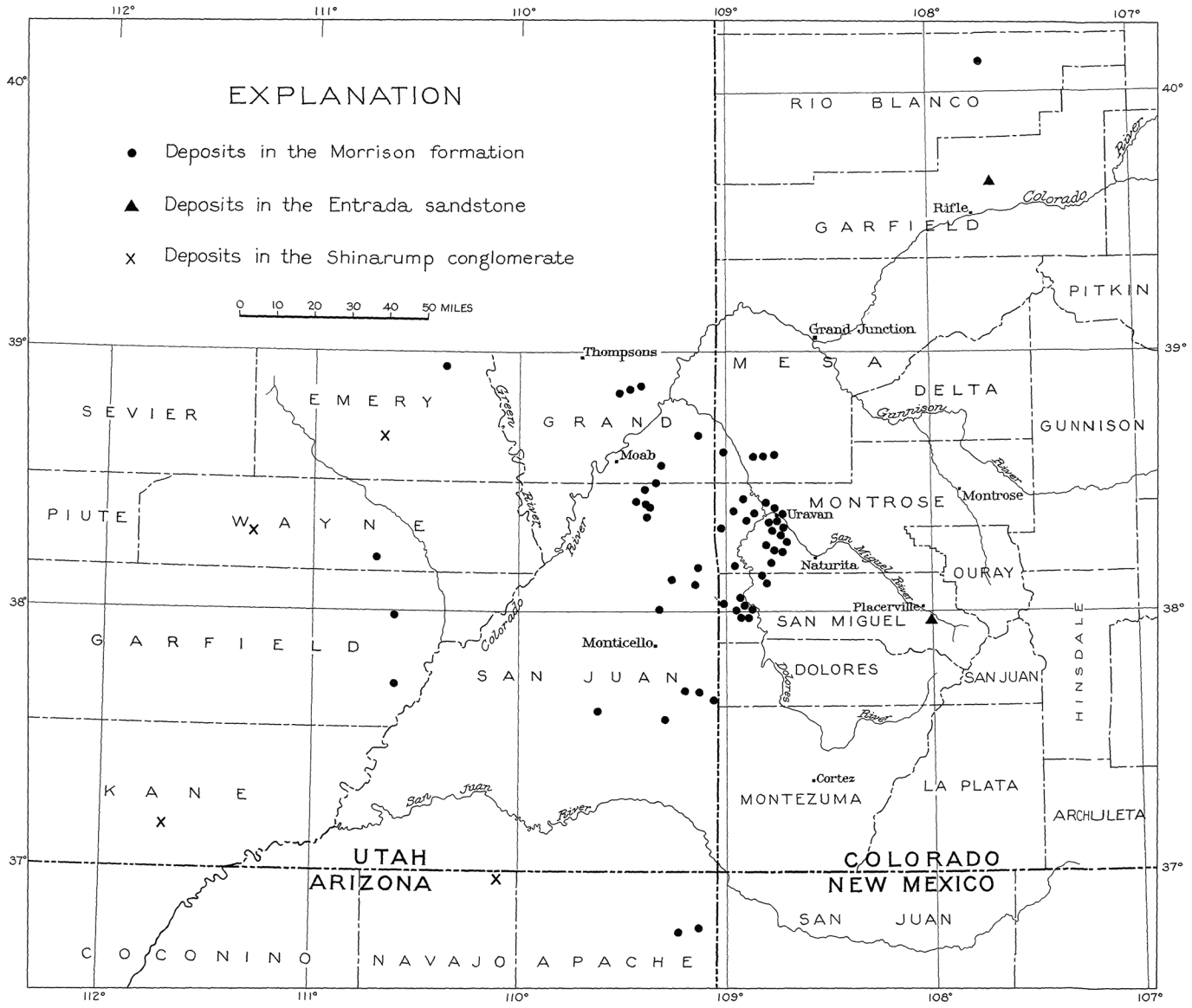
This chemical-mineralogical classification of the bauxite and high-alumina clays in Arkansas shows the percentages of the three principal oxides—aluminum, iron, and silicon—in the State's bauxite, bauxitic clay, and kaolinitic clay. (From Gordon, Tracey, and Ellis, 1958, fig. 30.)

deposits containing beryllium, feldspar, lithium, and sheet mica. Studies of pegmatite deposits in New England and the southern Black Hills were directed toward future composite mining of their minerals.

In October 1942, following discussions between Foster Hewett and Thomas Nolan of the USGS and mining engineer Sydney H. Ball,[46] a Special Assistant to the War Production Board's Deputy Director General for Industry Operations and a USBM consultant, the WPB suggested that the USGS investigate by spectrographic means several strategic elements in products from domestic mills, smelters, and electrolytic refineries. In the resulting Mill Products Program, sources of uranium and other fissionable materials were termed "trace elements" for security purposes. In November, USGS geologists were asked to collect nationwide, from a long and constantly changing list of these elements, samples of concentrates, tailings, slags, flue dusts, residues, and slimes to discover new sources of rare metals that could be developed quickly to meet urgent wartime needs. Particularly sought initially were recoverable amounts of easily reduced alumina, antimony, beryllium, bismuth, cadmium, cobalt, indium, molybdenum, nickel, tantalum, tin, tungsten, and vanadium. In addition to the preliminary spectrographic analyses by the field geologists, and chemical work in Washington, John C. Rabbitt spectrographically analyzed these and other samples at Harvard during 1943 and part of 1944. Rabbitt began his work with semi-quantitative analyses of the vanadium content of the more than 400 samples from the Permian black shales and associated rocks of the Phosphoria Formation obtained from locales in Idaho, Montana, Utah, and Wyoming not yet examined for that element. The USGS, the U.S. National Museum, the Bureau of Plant Industry, and the Tennessee Valley Authority (TVA) sent these samples to Harvard's Esper Larsen, Jr., during January–May 1942.

In May 1942, William Rubey and Vincent E. McKelvey began field investigations of Phosphoria vanadium between Cokeville, Wyoming, and Soda Springs, Idaho. They received John Rabbitt's spectrographic analyses of new samples in June and July; late in July, they completed their USGS report and sent copies to the USBM, the Metals Reserve Company, and the WPB. The geologists intended their field and laboratory studies to yield both applied and basic results, a goal since 1879, by discovering quickly new sources of rare metals to meet urgent war needs and also providing evidence for the origin of particular deposits as a guide to future prospecting. Rubey and McKelvey resumed their reconnaissance in August, aided by USGS geologist J. David Love, USGS chemist Victor North, and two USBM engineers. Measured and indicated reserves discovered in the Paris-Bloomington district, Idaho, totaled some 4.5 million tons, a 15-year supply for a 1,000-ton mill, while the Dry Creek and Swift Creek districts, Wyoming, appeared to have even larger tonnages of vanadium ore. Industry planned to produce 1,000 tons a day from the Sublette Ridge deposit, Wyoming. Significant amounts of uranium and zinc also occurred in some of the Phosphoria samples. Rabbitt also analyzed some 350 magnetite samples from 10 States. Between April and June 1942, USGS geologist James Balsley examined 67 deposits of titaniferous iron ores in California, Colorado, Minnesota, Montana, New Jersey, New York, North Carolina, Rhode Island, Virginia, and Wyoming. Balsley's subsequent detailed investigations of four deposits near Lake Sanford, New York, led to mining titanium from one of them and experimental work on a pilot plant to recover vanadium as a byproduct.

The urgent need for strategic and critical minerals also led the Board of Economic Warfare and the State Department to provide, respectively, $20,000 and more than $96,000 to support USGS investigations in the Caribbean and in Central and South America as part of an expanded effort to promote good relations among the American Republics. The State Department's funds were nearly double the sum it gave for this purpose in fiscal year 1941–42. Wendell Woodring, Steven Davies, and other USGS geologists examined chromite, copper, manganese, and



This map (originally at 1 inch = 20 miles) shows the distribution of vanadium deposits in the Shinarump Conglomerate (Triassic) and the overlying Entrada Sandstone and Morrison Formation (Jurassic) in northeastern Arizona, southwestern Colorado, and southeastern Utah. USGS geologists searching for mineral deposits on the Colorado Plateau concentrated initially on vanadium-bearing units but, beginning in 1944, refocused on the associated uranium. Studies and mapping completed before that year aided the new effort. (From Fischer, R.P., 1942, pl. 53.)

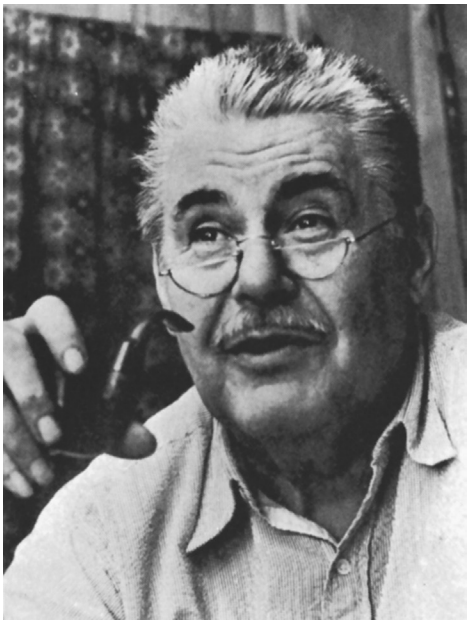
zinc deposits in Cuba and discovered there significant reserves of chromite. Other reconnaissances in the Caribbean sought additional bauxite deposits of grade and size similar to the soil-like occurrences discovered in Jamaica in 1942.[47] Donald White and his coworkers assessed Mexican sources of antimony, fluorspar, manganese, mercury, molybdenum, and tungsten. They located a tungsten district of high-production potential; their work also led to significantly increased production in the country's largest mercury district. Philip Guild evaluated antimony and chromite occurrences in Guatemala. Other USGS geologists studied manganese deposits in Panama; looked at copper, mercury, mica, molybdenum, and quartz in Colombia, where they were led by Quentin D. Singewald; investigated mica, nickel, and quartz in Venezuela; and examined, under William Pecora's leadership, bauxite, mica, and nickel in Brazil. There, William Johnston, Jr., now with the BEW, and others expanded their studies to include searches for piezoelectric quartz; in addition, they assessed beryl, tantalum, and tungsten in Argentina. Singewald's team also looked briefly at mineral deposits in Bolivia and Venezuela.

The Geologic Branch undertook only a few other investigations during fiscal year 1942–43, and they were all war related. At the request of Secretary Ickes, in his continuing capacities as coordinator of petroleum and solid fuels, Branch geologists again revised the oil and gas map of the United States, searched for additional deposits of coking coals suitable for western steel plants, and studied areas that promised to yield additional sources of oil. In cooperation with the USBM, they also looked for additional sources of helium for use in the blimps and other nonrigid aircraft now increasingly employed in antisubmarine patrols.

The Roosevelt administration gave increased attention to Alaska during 1942 and 1943 and especially to Federal work in the Territory. On January 16, 1942, Ickes reminded the Cabinet that a land route for conveying lend-lease aid through Alaska and personnel and supplies to Alaska now seemed more dependable than any sea route. Ickes, Frank Knox, Stimson, their staffs, and the Army Engineers collaborated in preparing recommendations for routes to connect Alaska by road to the conterminous States by way of Canada. On February 11, Roosevelt approved plans for constructing the Alaskan-Canadian (Alcan) Highway. Brigadier General Clarence L. Sturdevant, transferred from the Office of the Chief of Engineers, directed the Alcan project. Seven Engineer regiments (including three composed of black enlisted personnel led by white officers) and civilian firms under contract to the Public Roads Administration and the Army Engineers dealt with mosquitoes, mud, muskegs, and permanently frozen ground, or permafrost,[48] in building and then improving sections of the 1,420-mile-long road between Dawson and Fairbanks. The Alcan Highway,[49] completed at an estimated cost of nearly $140 million, opened on November 20, supplemented by an adjacent telephone line. Initial flights to the Soviet Union of lend-lease aircraft, the first of some 8,000 planes by war's end, via airfields from Great Falls, Montana, to Fairbanks, Alaska, began on September 29. The route also facilitated the passage of diplomats, including Foreign Minister Molotov and Andrei A. Gromyko, counselor at the Soviet embassy in Washington and ambassador there in 1943. Army Engineers also constructed the 1,200-mile-long, 4-inch-diameter Canadian Oil (Canol) pipeline, also approved by Roosevelt, to ship crude oil from the field at Norman Wells, on the Mackenzie River in the Northwest Territories, southwest to the refinery at Whitehorse in the Yukon Territory, a project favored by CNO Admiral King but not by Navy Secretary Knox. When Ickes finally learned about the $25 million effort, he termed it useless. General Somervell described Canol to the Truman committee in December 1943, but the committee could not stop the wasteful project, whose costs ballooned to more than $130 million.[50]

Funds directly appropriated for the Alaskan Branch to study the Territory's mineral resources during fiscal year 1942–43 remained virtually the same as in 1941–42, but monies from the War Department and the Office for Emergency Management increased the new total by more than threefold to nearly $1.25 million. Some 40 USGS geologists continued or began studies of chromium, coal, copper, iron, mercury, molybdenum, nickel, tin, tungsten, and zinc in southeastern Alaska, the Prince William Sound-Copper River region, the Cook Inlet-Alaska Railroad area, the Kuskokwim region and nearby portions of southwestern Alaska, and the western Seward Peninsula. As part of this work, Jack Kingston and Don J. Miller spent 5 weeks examining a nickel-copper deposit near Spirit Mountain in the Copper River region.

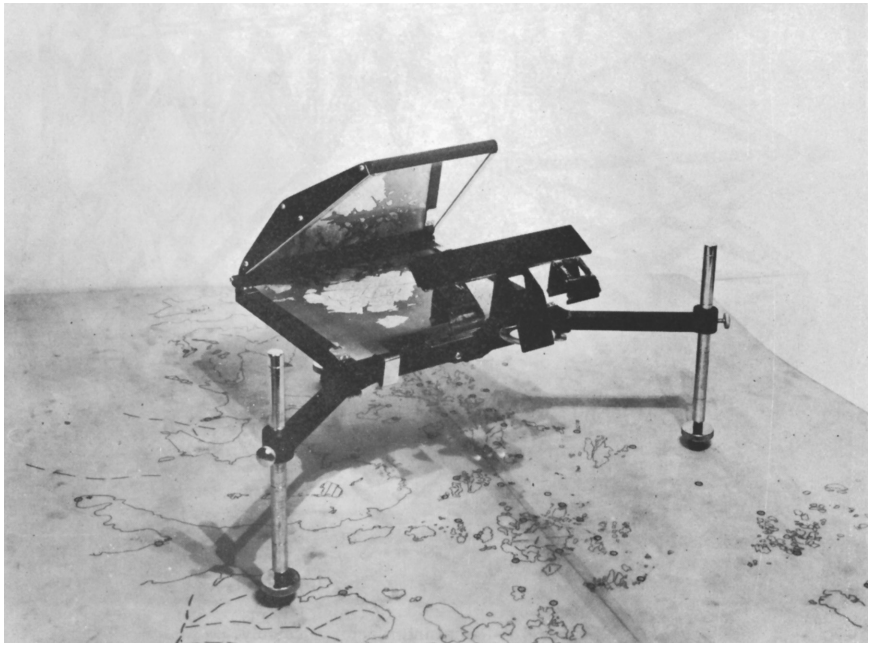
Alaskan Branch personnel devoted much of their energy to producing urgently needed maps of Alaska for military purposes, especially aeronautical-approach charts, shaded-relief maps, and other aids to aerial navigation. Those maps, many of which were produced by rapid approximate methods to meet immediate needs, did not warrant detailed surveying, but they proved accurate enough for aircraft flying at 200 to 300 miles per hour. Major Minton W. Kaye, who



William Drumm Johnston, Jr. (1899–1972), taught in Kentucky, New Mexico, and Ohio before joining the USGS for water-resources studies in 1928 and then investigations of chromite in the Western States and in Cuba. During 1942–46, Johnston managed the Board of Economic Warfare's explorations for iron, piezoelectric quartz, and other strategic-mineral commodities in the Minas Gerais and other areas of Brazil. He returned to the USGS to lead its Foreign Geology Section (later Branch) until 1964, while also working in Thailand and other countries. (Photograph from Dorr, 1975.)

commanded the USAAF's 1st Photographic Squadron, asked the Alaskan Branch to plan for compiling "cartographic data from aerial photographs"[51] to revise the U.S. Coast and Geodetic Survey's Alaskan Aeronautical Charts. Gerald FitzGerald, the Branch's senior topographic engineer, accepted the task of designing and perfecting production methods. To so do, FitzGerald, Charles F. Fuechsel, and David M. Landen used the Wilson photoalidade in developing the trimetrogon method of photogrammetry, which used three aerial cameras; one took vertical photographs and the others recorded oblique images that gave a horizon-to-horizon view at flight-line spacings of as much as 35 miles. As conventional photogrammetry used vertical photography at 3- to 4-mile spacings, the new maps were less accurate but far more rapidly and economically produced. The USAAF made the photographs and supplied the funds for compiling the maps. By the end of the fiscal year, the USGS assigned more than 150 people to this special work. FitzGerald, a USAAF Major since June 2, headed the Map-Chart Division, in the Office of the Director of Photography, now led by Lt. Colonel Kaye, at USAAF Headquarters. In 1943, the USAAF promoted FitzGerald to Lt. Colonel and renamed his unit the Aeronautical Chart Service's Aeronautical Chart Division, whose full Colonel in Charge he became in the following year. Fuechsel succeeded FitzGerald as chief of the Alaskan Branch's topographic mapping section.

The Topographic Branch drew on a total of nearly $3,419,000 in direct, transfer, and repay funds for fiscal year 1942–43, a sum $69,000 less than that available in the previous year. Of the Branch's $689,000 direct appropriation, $270,000 was available only for cooperation with State and municipal governments. The Branch remained concerned primarily with meeting military needs, aided by an Executive order on March 10, 1942, that abolished the Board of Surveys and Maps, established in 1919, and authorized the Director of the Office of Management and Budget to perform the Board's functions, and any others now deemed necessary, "to further coordinate and promote the surveying and mapping activities of the Government."[52] After the threat of Japanese invasion passed, members of the Topographic Branch became deeply involved in the production for the military of maps of foreign areas. Branch topographers mapped nearly 21,500 square miles in 30 States, the District of Columbia, and Puerto Rico; they worked cooperatively in



This 1942 model of the vertical sketchmaster used mirrors to allow the specialist to view details from a vertical photograph and simultaneously transmit them to a plotting sheet; it was an improved version of the portable instrument originally designed by USGS photogrammetrist James L. Buckmaster in 1931. Adjustments to the sketchmaster allowed for "scale changes and approximate tilt correction." The oblique sketchmaster similarly permitted the shift of data from oblique photographs. The universal sketchmaster was used with either type of photograph. Buckmaster also contributed to the development of trimetrogon photogrammetry and the USGS Airborne Control Survey System. (Quotation and photograph from Thompson, 1958, p. 7 and fig. 5; see also Buckmaster, 1946.)

17 States and Puerto Rico and with the TVA. Mapping also continued in Brazil to support USGS strategic-minerals investigations. Most of the Branch's effort abroad involved producing maps of strategic areas, or parts within them, outlined by the War Department, under the Loper-Hotine Agreement of May 1942 that divided Allied mapping responsibilities worldwide. Nearly 67 percent of the Topographic Branch's 241 quadrangles published and the 88 percent of the 684 mapped completely or still in progress at the close of the fiscal year were within the strategic area designated by the War Department.

The Topographic Branch also issued the Chesapeake Bay sheet for the 1:1,000,000-scale International Map of the World. The Photographic Mapping Section produced topographic maps of 5,750 square miles and planimetric maps of 14,250 square miles, in addition to the maps completed at the Chattanooga office, which remained fully engaged in cooperative work for the TVA and the Army Engineers. Two shifts were busy at the Arlington office, now with increased facilities and responsible for maintaining a central laboratory for designing, testing, repairing, and adjusting the special optical equipment needed for stereophotogrammetric work. The number of Secretarial appointees in the Branch peaked at 745 on September 30, 1942, but 59 of those persons were furloughed for military service. Herbert Hodgeson, Pacific Division Engineer, retired on November 30, 1942; on the following day, Conrad A. Ecklund succeeded Hodgeson.[53]

The War and Navy Departments, the War Production Board, industrialists, and engineers employed under war contracts called on the Water Resources Branch for more than 4,000 special reports during fiscal year 1942–43. Branch scientists and engineers drew on total funds of about $3,219,000, a sum $33,000 less than the previous year. Of that amount, the appropriations statute directed that $975,000 could be spent only for cooperative work with the States, counties, and municipalities, whose governments more than matched that amount by providing some $1,038,000. The Army Engineers again led the contributors among the other Federal agencies by furnishing nearly $645,000, a loss of only $14,000 from fiscal 1941–42, but the WPB reduced its transfer funds by $34,500, or more than 70 percent, and the Department of Agriculture halved its transfer funds.

Monies received supported the Water Resources Branch's studies and assessments of water supplies for cantonments, naval stations, military hospitals, training fields, airfields, munitions industries, manufacturing plants, hydraulic and steam powerplants, emergency housing, expanded irrigation for increased production of food, inland-waterway navigation, flood protection, supplements during droughts, and replacements for sources that might be damaged by bombing.[54] Reports covered areas in every State in the Union and in the Territories of Alaska and Hawaii, but most of them centered on the industrial regions of the East, South, and Far West. Branch personnel continued, as much as possible, regular activities to maintain continuity of records. They measured stage, quantity, and availability of surface waters at some 5,000 gaging stations and recorded periodic observations of water level or artesian pressure in some 7,000 wells, numbers representing no significant increase in sites from the previous year. Leland Wenzel published his study of methods for determining permeability in water-bearing materials, especially those for discharging wells. Other continuing activities included the monthly *Water Resources Review* (now including groundwater data), administration of some responsibilities relating to permits and licenses of the Federal Power Commission, investigations of water problems along the U.S.-Canadian boundary, and the laboratory analysis of more than 2,800 water samples.

Of the six water-supply battalions and four water-supply companies (provisional) continued or formed by the Army, five battalions and two of the independent companies served in the Mediterranean and European Theaters; one battalion and the remaining two companies went to the South Pacific Area. The Army

Engineers commissioned 10 USGS groundwater geologists and assigned them to the water-supply battalions or to headquarters' staffs. Among these officers, Richard C. Cady (killed in North Africa in January 1943), R. Maxwell Leggette, and Harold Thomas became Majors. Frank Foley, Raymond Nace, and Reuben C. Newcomb began their service as Captains. Roger C. Baker, Bernard Fisher, William Rasmussen, and Stuart L. Schoff pinned on 1st Lieutenants' bars.

The Conservation Branch's work expanded as the need for raw materials increased the prospecting and development of public-land resources, but, to support this work, the Branch received only $583,000 for fiscal year 1942–43, an increase of just $5,000. Branch members concentrated on increasing the application of these resources to the war program. The Mineral Classification Division acted on 7,900 cases, about 7 percent more than in the preceding year, and made geologic investigations in 8 Western States. The Mining Division supervised operations on 700 public-land properties, 268 Indian properties, and 3 Secretarial authorizations. Substantially increased production of coal, sodium, potassium salts, and phosphate rock from public-land properties yielded correspondingly higher accrued revenues. Searches intensified for potash and associated aluminum and magnesium, especially after a Secretarial order removed restrictions on granting permits and leases.[55] During the fiscal year, the production of coal and vanadium from Indian lands considerably increased, as did prospecting with a view to developing the known deposits of copper, tungsten, uranium, and vanadium; low-grade lead and zinc ores also were worked. The Oil and Gas Leasing Division supervised operations on nearly 4,500 public-land properties, some 4,200 leaseholds on Indian lands, and 18 properties under lease in Naval Petroleum Reserves Nos. 1 and 2 in California. The production of crude oil, natural gas, natural gasoline, and butane from the public lands rose substantially during the fiscal year, but production of these energy resources declined in the NPRs and royalties from them fell by $141,000 to $493,000. Oil and gas production from Indian-land leaseholds also rose a little, owing principally to a substantial increase from Oto tribal lands in Oklahoma. Helium-bearing natural gas was discovered and developed on Navajo lands in New Mexico. Royalties and related revenue from operations on Indian lands rose to slightly above $2.6 million.

Rubber for the war effort remained a problem outside the purview of the USGS. On June 12, 1942, Roosevelt supported a scrap-rubber campaign in a radio address because the war with Japan cut off 92 percent of the America's peacetime supply. In July, with domestic production still lagging, Congress passed a bill to create an independent "rubber czar." Roosevelt vetoed the legislation to prevent it from negating centralized control under the War Production Board, but he appointed a three-person committee to review the problem. To lead the survey, the President tapped financier Bernard M. Baruch, one of his long-term advisers, who served on the Council of National Defense's Advisory Committee and chaired the War Industries Board during World War I. Baruch, joined by Karl Compton and James Conant of the Office of Scientific Research and Development, recommended a complete reorganization and consolidation of the Federal agencies concerned with the rubber program and increased emphasis on conservation and production of synthetic rubber. In September, to resolve the crisis, Roosevelt appointed William R. Jeffers, the Union Pacific's president, to head the rubber program as part of the WPB, with authority to direct the Rubber Reserve Company and other agencies in carrying out some of the program's activities.[56] Secretary Ickes, as Petroleum Coordinator, received specific authorization to conduct or promote developmental research in the production and manufacture, from petroleum and natural gas, of the butadiene needed for producing both aviation gasoline and synthetic rubber. Ickes also supervised the operation of plants that produced synthetic-rubber raw materials from oil and gas.

By August 1942, the lack of synchronization in completing parts for weapons, such as those processes that produced tanks with treads but no armor plate, or carburetors without engines, thoroughly alarmed U.S. military authorities. In mid-September, to solve the weapons problem, the WPB's Donald Nelson invited investment-banker Ferdinand Eberstadt, head of the Joint Army and Navy Munitions Board and Baruch's protégé, to take charge of priorities for the WPB. Eberstadt viewed the production problem as one of controlling the flow of aluminum, copper, and steel. He developed a plan in which orders for finished products figured as the precisely calculated sum of all the parts, components, and materials. The WPB did not adopt Eberstadt's Controlled Materials Plan until November and then did so in a circuitous fashion through a recommendation by the Office of Economic Stabilization (OES). An Executive order established the OES[57] on October 3, immediately after the enactment of the amendment of the Emergency Price Control Act that authorized the President to stabilize prices, wages, and salaries affecting the cost of living. Those powers passed to the OES and its new director James F. Byrnes, who, with Baruch's backing, served South Carolina in Congress for 30 years before Roosevelt appointed Byrnes to the U.S. Supreme Court in June 1941. Byrnes resigned from that bench to become Director of Economic Stabilization and, as one of his initial actions, recommended applying Eberstadt's plan. Only after Roosevelt, Byrnes, and the War and Navy Departments agreed in mid-October to use Eberstadt's design as a means to regulate the war economy did the WPB adopt the plan.

The Nation's oil supply continued to be another nagging problem in 1942. In spite of Ickes' best efforts, the USBM estimated that the demand for all oils reached an all-time peak of 442 million barrels in the last quarter of 1941. That level dropped during the first quarter of 1942, but it remained higher than the corresponding period in 1941. As imports fell somewhat, supply sustained demand only through a reduction of more than 27 million barrels in the stocks of refined oils. In the second quarter of 1942, overall demand declined to almost 3 percent less than in the same interval in 1941; the greatest reduction involved motor fuel, but requests for residual and distillate fuel oils actually increased. Rapidly dwindling stocks and reduced movement of supplies by tankers, in part due to losses to German submarines, produced a serious supply problem on the East Coast. The Roosevelt administration introduced a gasoline-rationing system in May in the Eastern States and encouraged industrial plants using fuel oil to convert to coal. Rationing of heating oil in the main consuming areas began on October 1; nationwide gasoline rationing followed in December. By the fourth quarter of 1942, demand declined only 5 percent from the level in the corresponding peak period of 1941. The increasing military need for petroleum by the United States and its allies indicated additional shortages ahead. The American Petroleum Institute estimated that pools discovered during the fiscal year added only some 260 million barrels to the Nation's crude-oil reserves. Only additional new finds would supply wartime requirements and keep the industry within an efficient rate of production.

An Executive order on October 15, 1942, extended the boundaries of California's Naval Petroleum Reserve No. 1,[58] but now Roosevelt and Ickes looked north to much larger Federal holdings. In April, Secretary and Coordinator Ickes promised the Cabinet that exploration for oil in Alaska would begin immediately, but only in November did Ickes recommend to the President to begin a Federal program to explore for and develop oil in the Territory. The administration issued a public-land order on January 22, 1943, withdrawing from entry potential (but unproved) petroleum-bearing areas in the Territory, including all lands north of the Brooks Range's drainage divide. On March 30, geologist William T. Foran, then on active duty as a Lieutenant in the U.S. Naval Reserve (USNR), suggested to the Bureau of the Budget's oil consultant several reasons for taking a renewed and more careful look at Alaska's Naval Petroleum Reserve No. 4 (NPR–4 or "Pet–4").

The Reserve, established by President Warren G. Harding's Executive order of February 27, 1923, encompassed a large area in northwest Alaska, north of the Brooks Range divide.[59]

USGS geologists began detailed mapping in the future reserve's area in 1901 and reported oil seeps at Cape Simpson in 1919. Foran served two seasons with USGS parties during the 1923–26 reconnaissance of NPR–4 planned by Alfred Brooks and funded by the Navy Department. Geologists Foran, James Gilluly, John Mertie, Jr., Sidney Paige, Philip Smith, and Walter R. Smith and topographers Gerald FitzGerald, E.C. Guerin, R.K. Lynt, James E. Whitaker, and O.L. Wix, sailing in engine-powered small vessels from their principal supply base at Nome, combined to map and assess coals and oil seeps in areas totaling some 2,150 square miles. They also gathered information on an additional 10,000 square miles. These parties, using U.S. Coast and Geodetic Survey charts to fix the coastline, completed in 1924 a 1:500,000-scale map of the northwestern part of NPR–4 from Cape Beaufort to Cape Simpson, based on up-river traverses from the Kukpowruk to the Colville.

On December 2, 1942, Roosevelt's Executive order abolished the Office of the Petroleum Coordinator for War, established on May 28, 1941, and replaced it with the Petroleum Administration for War (PAW), which received on December 17 all of the defunct organization's funds, personnel, property, and records. Secretary Ickes, now Petroleum Administrator, received greater responsibilities and power to "establish basic policies and formulate plans and programs to assure * * * the conservation and most effective development and utilization of petroleum in the United States and its territories and possessions,"[60] provided his directives did not conflict with those issued by the WPB's Nelson. The order authorized Ickes to compile data and make surveys, obtain estimates, make recommendations, effect proper distribution of U.S. petroleum, consult on the movements of tankers and construction of oil and gas pipelines, and collaborate with State governments. Roosevelt also asked Ickes to collaborate with the appropriate Federal departments and agencies required to determine plans and policies with respect to foreign petroleum activities, to issue directives to units of the U.S. petroleum industry directly or indirectly engaged in activities abroad concerning the physical operations of their foreign facilities, and to be the channel of communication on foreign-petroleum matters between the Federal Government and these U.S. petroleum-industry units. The order allowed Ickes to appoint, subject to the President's approval, a formal Deputy Administrator.

By the end of 1942, although the United States still struggled with production problems, its forces won several major victories in the Pacific. Two days after Corregidor fell, U.S. naval fliers turned back a Japanese force en route through the Coral Sea to invade Port Moresby on New Guinea's southern shore. Navy fliers damaged one of the two Japanese fleet carriers, wrecked the other's air group, and sank one light carrier, in return for the loss of one fleet carrier and damage to the other. Meanwhile, in the southern Solomons, other Japanese forces occupied and established a seaplane base on Tulagi Island just north of the much larger Guadalcanal. Decoded messages from Japanese diplomats and the Imperial Navy disclosed the Japanese plan to attack Midway. On June 4, aircraft from four Japanese fleet carriers struck that island. Daring leadership from Rear Admiral Raymond A. Spruance (who replaced a hospitalized Halsey), clever and determined flying, and luck enabled aircraft from three U.S. fleet carriers to ambush the Japanese carriers. They sank all four, but Japanese planes downed only one American carrier. Far to the north, Japanese aircraft from two smaller carriers attacked Dutch Harbor on Unalaska, and other shipborne forces captured Attu and Kiska in the western Aleutians, but those carriers and their escorts came south too late to help the Japanese main fleet reverse the outcome off Midway.[61] On New Guinea, Australian troops

defeated Japanese overland efforts to conquer Port Moresby and also successfully defended Milne Bay at the eastern end of New Guinea.

President Roosevelt and Admiral King, changing American plans from hold to attack, encouraged and facilitated an American offensive in the southern Solomons. On August 7, the 1st Marine Division (reinforced) landed on Tulagi, adjacent smaller islands, and Guadalcanal. The Marines quickly captured the lesser islands, but taking Guadalcanal required a long, bitter, and costly struggle against continuing Japanese attacks by air, land, and sea. In a series of furious battles off Guadalcanal, Imperial naval and air forces sank two U.S. fleet carriers, damaged two others, and sank or ruined many cruisers and smaller warships. In October, Nimitz placed Halsey in command of the South Pacific Area. Halsey took hold, American morale rose, and the Japanese continued to suffer severely themselves, losing carriers of their own, two other capital ships, and many other combat vessels. The Japanese failed to interdict the U.S. Navy's supply line to Guadalcanal or break the Marine-Army cordon on the island, lost the battle of attrition, and withdrew their remaining sick and starving troops. Victory on Guadalcanal,[62] and the successful operations by MacArthur's forces between late November 1942 and late January 1943 that took the Buna-Gona positions on New Guinea's northern coast, proved the Japanese were not the invincible jungle fighters that many feared.

Late in 1942, the Allies also reversed the flow of Axis successes in Africa and Russia. In May and June, the Germans renewed their offensive on the Eastern Front, aiming to smash the revived Soviet forces and capture vital Caucasus oil. They captured Maikop and its oil installations in August but only after the Soviets damaged production facilities.[63] After Hitler diverted armored units to Stalingrad, German forces took the Malgobek oil field in October, but they did not reach fields at Grozny or Baku (which produced 10 times more oil than Maikop) or the port and refinery facilities at Batumi. The Russians held the German Sixth Army at Stalingrad and surrounded it there a month after Marshal Zhukov's army groups began a major counteroffensive in November. In North Africa, Field Marshal Rommel's Italo-German army captured Tobruk and reached a point only 60 miles from Alexandria in July. Without additional troops, equipment, ammunition, and especially fuel, Rommel could not advance further; he withdrew his forces to defensive positions early in September. The British 8th Army, under its new commander, Lt. General Bernard L. Montgomery, began a massive counterattack at El Alamein on October 23. Rommel and his surviving Axis troops, forced to retreat on November 4, did not stop until they reached Vichy Tunisia. Roosevelt and Churchill, after discussions with Molotov, agreed in June to have their forces invade western North Africa in Operation Torch and timed it to match Zhukov's offensive. Stalin and Molotov did not see Torch as the true second front, especially as shipments of lend-lease equipment were reduced by 60 percent when Arctic convoys were temporarily suspended.

On November 8, as the Axis troops retreated into Libya, three task forces of mostly American troops, commanded by Lt. General Dwight Eisenhower, Marshall's protégé, landed at Algiers and Oran in Algeria and at and near Casablanca in Morocco, where individual French garrisons either aided or opposed the invasions before being ordered to stand down 3 days later. USGS groundwater geologists Maxwell Leggette and Raymond Nace landed as officers in Operation Torch's water-supply units. The Anglo-American forces then raced east to threaten Rommel's western flank, but they did not arrive in time to prevent his linking up with heavily reinforced German forces in Tunisia. In response to Torch, the Wehrmacht also occupied Vichy France but gained only scuttled warships at Toulon. Italian troops took over Corsica.

As the Allied campaign continued in North Africa, and after the War Production Board adopted Eberstadt's Controlled Materials Plan, Chairman Nelson reorganized the WPB and regrouped its industry and commodity branches. The new Steel Division comprised the old Iron and Steel, Tungsten and Molybdenum, Manganese and Chromite, and Nickel Branches. Nelson placed the new Steel Division and the existing Copper and Aluminum-Magnesium Divisions under the Director General for Operations, who, in turn, reported to Eberstadt as Program Vice Chairman. The Mining, Mica-Graphite, Tin-Lead, Zinc, and Miscellaneous Minerals Branches were linked in a Minerals Bureau, the Chemicals and the Cork-Asbestos Branches merged with other industry branches in a Commodities Bureau, and the Building Materials Branch passed to the Construction and Utilities Bureau. Toward the end of November 1942, the WPB established an Office of Production Research and Development, with physicist Harvey N. Davis, president of Stevens Institute of Technology, as Director and the ubiquitous Charles Leith as Chief of its Metals and Minerals Branch.

When the polls for the American midterm elections opened on November 3, fierce fighting continued unabated in Stalingrad, Operation Torch was a month behind schedule, and Guadalcanal appeared to be a stalemated morass. Only some American voters expressed their concern at the polls; voter turnout for choices for the 78th Congress proved very light. As usual, the party out of power won a larger number of the contested seats. The Democrats lost 50 seats in the House, retaining a majority there of just 10 Members. In the Senate, although the Republicans gained 9 seats, the Democrats still held a 21-seat edge.[64]

When President Roosevelt gave his State of the Union Address to the new Congress on January 7, 1943, some aspects of the war still looked bleak, but none seemed hopeless. Japan now controlled seas, lands and resources that stretched from Burma on the west to the Gilbert and Marshall Islands on the east, and from the western Aleutians on the north to the Netherlands East Indies on the south. The Greater East Asia Co-Prosperity Sphere also included Korea, much of mainland China (including Manchuria), French Indochina, and Thailand. Axis-controlled territory and resources in Europe stretched from Brest eastward to Stalingrad and from the North Cape southward to Mareth in North Africa. In the United States, Federal employees now worked a 48-hour week, with no holidays, but an Executive order deferred them from the draft and the demands and risks of combat.

Roosevelt, after reviewing the previous year's events, goals achieved, and those remaining to be met, suggested that it was "wholly possible that freedom from want—the right of employment, the right of assurance against life's hazards—will loom very large as a task of America during the coming two years."[65] Cracking the Axis defensive perimeters seemed a more daunting mission. After taking Guadalcanal, U.S. forces faced a difficult advance northwest up the rest of the Solomons to join in isolating and reducing the Japanese air-naval base at Rabaul. The German Sixth Army surrendered at Stalingrad on February 2, but the Soviets faced new Axis lines along the Dnieper River. The Germans planned to retake the lands regained by the Soviets and to hold Tunisia, where Hitler finally placed Rommel in overall command on February 23.

Between January 14 and 24, 1943, Roosevelt, Churchill, and their staffs met in Algeria at the Symbol Conference in Casablanca. After the Prime Minister briefed the President on his discussions with General de Gaulle in Marrakech on January 9 about future roles for the Free French, the two leaders agreed to delay the cross-channel invasion of France until 1944. The Allies, after taking Tunisia, would invade Sicily rather than Sardinia. Roosevelt and Churchill named Eisenhower as a four-star supreme commander in the Mediterranean. The two leaders also decided,

at Admiral King's continued urging, to increase to 30 percent their allocation of resources to the Pacific. To win the Battle of the Atlantic, where British (Enigma) decrypts gave the Allies a significant edge, they would build more antisubmarine carriers and their escorts, deploy airborne magnetic detectors and high-frequency direction finders, and use "Hedgehog" weapons to supplement improved depth charges. The Allies also would use longer range aircraft, and bomb German targets day and night, giving priority to sites of U-boat construction or repair before striking aircraft plants, ball-bearing factories, and automotive plants. At the final press conference on January 24, Roosevelt announced the Allies' demand for unconditional surrender to give the Axis no World War I-style excuses and to placate a furious Stalin, who might make a separate peace with Hitler. Churchill, remembering his own fight-on declaration in 1940 and also wishing to keep the Soviets in the war, hid his surprise and endorsed Roosevelt's principle. Roosevelt and Churchill confirmed these decisions at the Trident Conference (May 15–25) in Washington, where they reset the invasion of France to May 1, 1944.

The President and the Prime Minister also agreed at Casablanca to resume the highly secret talks on the development of an Anglo-American nuclear weapon. Roosevelt accepted provisionally Vannevar Bush's recommendation of December 16, 1941, to place the U.S. Army in charge of the weapon's construction. The British Maud Committee recommended development, first to Lyman Briggs, the U.S. S–1 Section's Chairman, and then, on January 19, 1942, directly to Bush, Director of the Office of Scientific Research and Development (OSRD). On March 9, Bush summarized for Roosevelt the organization and status of American work on Tube Alloys, the code name for the joint project, and suggested that the special bomb could be completed in 1944 if the President would authorize expediting the effort.[66] Roosevelt so did 2 days later. The Engineering Planning Board, chaired by Eger Murphree, and its Engineering Studies and Pilot Plants group reported directly to Bush. Briggs' S–1 Section and the three contract units—Measurements and Atomistics, led by Arthur Compton; Diffusion, Centrifuges, Chemistry, and Power, led by Harold Urey; and Electromagnetic Methods, led by Ernest Lawrence—all reported to the National Defense Research Committee's (NDRC's) Chairman James Conant. Compton, Lawrence, and Urey also continued to serve on S–1. The project would be sufficiently advanced by the summer, Bush suggested, to pass it to War Department management for completion. In June 1942, when Roosevelt and Churchill met in Washington to discuss a second front and to plan Operation Torch, they also decided to share their atomic research with each other but not with the Soviets. On July 12, Roosevelt ordered Bush to cooperate with the British. When Roosevelt and Churchill agreed that all subsequent work would be done in America, James Chadwick and other British scientists came over to aid the project.

Roosevelt approved on June 17 his Top Policy Group's recommendation to pass all of OSRD's work on the atomic-bomb project to the Army Engineers for full-scale development and manufacture. Two days later, General Reybold's representatives and Bush discussed the new administrative office the Army Engineers intended to establish in New York City within their North Atlantic Division's headquarters. On June 26, Generals Reybold and Somervell agreed on the Laboratory (later District) for Development of Substitute Materials as a cover name for the bomb project. Reybold's general order of August 13, effective on the 16th, changed the Laboratory's name to the Manhattan District, also known as the Manhattan Engineer District (MED).[67] To lead the military and civilian Manhattan Project, Secretary Stimson and Generals Reybold and Somervell selected Colonel Leslie R. Groves, Jr., the Deputy Chief of the Army Engineers' Construction Division, who supervised the War Department's $10 billion construction work (including the new Pentagon Building). Groves was promoted to Brigadier General on September 6 and took over the MED later that month.

Franklin Delano Roosevelt (1882–1945), the 32d President of the United States (1933–45) and Theodore Roosevelt's cousin, was educated at Harvard and Columbia. FDR practiced law in New York before entering politics in 1910 as a State senator. He served as Assistant Secretary of the Navy during 1913–20 before becoming the Democrats' unsuccessful candidate for Vice President. In 1921, poliomyelitis cost him most of his physical mobility. FDR was Governor of New York in 1929–33 until sworn in as President. Roosevelt, a consummate politician, managed the socio-economic New Deal, the U.S. recovery from the Great Depression, and, as Commander in Chief, prewar aid to Britain and America's part in winning World War II. He also contributed significantly to the establishment of the United Nations. Although FDR appointed the conservation-oriented Harold Ickes as Secretary of the Interior, the President was less successful in establishing a national policy for the conservation and use of the Nation's land and water resources. In this photograph, taken during the first week of December 1943, FDR presents a Legion of Merit to General Dwight Eisenhower. (Photograph from the Library of Congress, Prints and Photographs Division, 3c35307.)

Bush feared that General Groves would not work harmoniously with the project's scientists. Groves, as crusty as he was competent, invigorated the bomb project. He held out successfully for a minimal supervisory committee, absorbed $400 million in startup funds, and moved quickly to secure materials and sites. On September 18, Colonel Kenneth D. Nichols, Groves' executive officer, obtained the MED's initial supplies of uranium by purchasing 1,250 tons of high-grade pitchblende, more than 65 percent uranium oxide, from the Shinkolobwe Mine, in the Belgian Congo's Katanga Province, that had been spirited out of Africa 2 years earlier.[68] After Henry Tizard and Frédéric Joliot-Curie warned the Belgian Government in 1939 that the uranium ore at the Olen refining plant, east of Antwerp, should be kept out of German hands, the Union Minière du Haut Katanga's managing director sent the ore stored at Shinkolobwe to safety in New York, but the ore at Olen passed to the Third Reich when the Belgians surrendered in 1940. Additional, but much lower grade ore, less than 1 percent uranium, came from Canada, whose scientists were experimenting with a heavy-water nuclear pile.[69] A USGS–USBM domestic program subsequently supplied more ore, but it was of equally low grade.

Groves also began planning for and organizing construction of facilities at three U.S. locations. Site X at Oak Ridge, west of Knoxville, in Tennessee, would use TVA waterpower to separate fissionable uranium-235 by gaseous diffusion. Site W's plant at Hanford, west of Pasco, in Washington State, would use Columbia River power to produce plutonium. At Site Y at Los Alamos, northwest of Santa Fe in New Mexico, J. Robert Oppenheimer led the bomb-design team, whose members later included Niels Bohr. The MED also encompassed other research and development efforts at academic and industrial sites across the country from Berkeley, California, to New York City and Washington, D.C., where Philip Abelson and others worked at the Naval Research Laboratory and elsewhere on separating uranium-235 from uranium-hexafluoride gas. On December 2, 1942, Enrico Fermi and his colleagues at the University of Chicago's Metallurgical Laboratory (Met Lab), directed by Arthur Compton, used synthetic-graphite control rods free of boron to produce a self-sustaining nuclear reaction in the atomic pile at their laboratory under the stands of Stagg Field. After failing in 1939 to interest the Navy in the potential of nuclear energy for power, Fermi and his earlier team at Columbia, including Leo Szilard, Hans A. Bethe, and Edward Teller, demonstrated during 1940–41 the feasibility of controlled chain reactions.

Earlier in 1942, Glenn Seaborg joined the Met Lab to develop plutonium-separation processes. By late 1942, Allied intelligence suggested the Germans might be ahead of the MED in the race to develop a nuclear weapon. The Allies still feared that the German physicists would succeed in constructing and operating a water-controlled and slow-neutron pile, using uranium from the Czech and Belgian ores, to produce radioisotopes for an explosive weapon, or, at least, a "dirty" bomb. In 1943, the year Bohr escaped from Denmark, Norwegian commandos and then Allied bombers temporarily shut down the heavy-water plant at Vermork and destroyed its stock of heavy water.[70] The Germans removed some of the processing equipment and reassembled it in Hechingen, southwest of Tübingen. Early in 1944, the Norwegians also sank the lake ferry carrying Norsk Hydro's remaining supplies of heavy water. Japan began its own nuclear-weapon program in April 1941; a year later, the Soviet Union resumed its larger effort.

As the nuclear quests continued, President Roosevelt planned coeval changes in the War Production Board. Early in February 1943, the WPB announced plans to coordinate and correlate the mineral programs run by several Federal agencies. WPB Chairman Donald Nelson established a Mineral Resources Coordinating Division, to be aided by a Minerals Resources Operating Committee and a Minerals and Metals Advisory Committee. Alan Bateman (BEW), Foster Hewett (USGS), and Charles Leith (WPB) became members of the Minerals and Metals Advisory

Committee. Roosevelt now planned to replace Nelson with Bernard Baruch and make Ferdinand Eberstadt his chief deputy. In mid-February, however, on the very day that the President intended to announce the change, Nelson forestalled the move by asking for Eberstadt's resignation. Nelson, who wished to prevent military control of production, increasingly worried about Eberstadt's close ties with and support by the military. Rather than endure another controversy by firing Nelson immediately, Roosevelt dropped the matter. Instead, Charles Edward Wilson, president of General Electric since 1940 and manager of the WPB's production schedules since September 1942, became the WPB's Executive Vice Chairman. In March, Julius A. Krug, Director of the Office of War Utilities, was appointed Nelson's Vice Chairman in charge of Materials Distribution and Chairman of the Requirements Committee. In April, Interior Secretary Ickes, in his capacities as Petroleum Administrator for War, Chairman of the War Manpower Commission, and Director of the Office of Defense Transportation, also joined the WPB. Eberstadt's Controlled Materials Plan, once in place, continued to direct the efficient distribution of raw materials and made possible the successful production program of 1943.

During the early spring of 1943, Congress began the postwar planning requested by the President on January 7. The legislators, exhibiting continued opposition both to the New Deal and isolationism, concentrated on economic policy and international cooperation. On February 15, Senator Walter F. George (D–GA) proposed establishing a special committee on postwar economic policy and planning to gather and assess information to prepare Congress to make the principal contribution to "the achievement of a stable economy and a just peace."[71] On March 12, the Senate established a 10-man committee with George as its chairman. Senator George favored creating employment opportunities by free enterprise rather than by the Federal Government's "pump-priming" that marked the last decade. Not to be outdone, Representative Everett M. Dirksen (R–IL) immediately asked his colleagues to set up a committee similar to the one led by Senator George. Four days later, Senators Joseph H. Ball (R–MN), who supported Donald Nelson's appointment to the WPB, Harold H. Burton (R–OH), Carl Hatch (D–NM), and Joseph L. Hill (D–AL) reported the resolution they had been delegated to prepare for committing the United States to participate in an international organization. Their resolution proposed that America take the initiative in calling meetings for the purpose of forming an organization of united nations. The new organization would have authority to aid in prosecuting the war, administer Axis-controlled areas as they were liberated, manage relief and assistance in economic rehabilitation, establish means for peacefully settling international disputes, and assemble and maintain its own military force. After the House Appropriations Committee eliminated the appropriation for the National Resources Planning Board in August 1943, President Roosevelt placed the burden and responsibility for continued planning entirely on Congress. In response, the legislators did not rush to organize the international body.

A shift in prosecuting the war while planning for the coming peace also occurred in the USGS before the end of February 1943. Walter Mendenhall, the agency's Director since 1930, retired officially on February 27, after more than 48 years of service. Mendenhall reached the mandatory retirement age of 70 on February 20, 1941, but President Roosevelt twice extended Mendenhall's appointment for another year.[72] Secretary Ickes decided against asking for a third extension so that he might have a hand in selecting the Director who would plan for and lead the postwar USGS. Mendenhall guided the agency through the Great Depression of the 1930s and into the turbulent war years. Mendenhall's Quaker background made the latter task more difficult for him, but he acted on his assertion at a congressional hearing that "The effort of every individual and of every agency, legislative or executive, we know must be thrown completely into the war effort."[73]

Geologist William Embry Wrather (1883–1963) worked for the USGS in 1907 and then convinced wildcatters in Texas of geology's value in finding oil. His 1918 Desdemona field was the largest discovery in the State since Spindletop. Wrather served in 1942 as Alan Bateman's deputy in the Board of Economic Warfare's Metals and Minerals Division before succeeding Walter Mendenhall as USGS Director in 1943. During the next 13 years, Wrather and Thomas Nolan completed major reorganizations of USGS Branches (later Divisions) to incorporate recent scientific and technological advances and to respond to increased wartime needs. They established the USGS Science Advisory Committee and opened three new regional field centers but avoided creating regional directors and kept the chiefs of the program divisions in Washington. In 1950, they succeeded in restoring USGS block funding (discontinued since 1888) under the aegis of surveys, investigations, and research. Wrather, increasingly ill, retired in 1956. (Photograph from the USGS Denver Library Photographic Collection, Portraits, as port0309, https://www.sciencebase.gov/catalog/item/51dda276e4b0f72b4471df5d.)

Mendenhall's directorship may well have been the most important in the agency's first century. Under his guidance, the USGS position as a research institution was firmly established, so solidly that subsequent challenges before 1979 proved to be only temporary. In reporting Mendenhall's retirement, the *Engineering and Mining Journal* gave him this accolade:

> **To have combined outstanding achievement in science with a long record of devoted public service is an accomplishment worthy of any man's respect. To these attainments, Dr. Mendenhall has added another: he provided for the men who have worked under his direction an environment in which scientific research, technical integrity, and practical skill could flourish, to the enrichment of all mankind.[74]**

Pending the appointment of Mendenhall's successor, Ickes selected Julian Sears, USGS Administrative Geologist since 1924, as Acting Director, to repeat Sears' earlier service on the occasions when Mendenhall was ill, traveling, or serving as Acting Assistant Secretary or Acting Secretary of the Interior. The Association of American State Geologists (AASG) held its annual meeting in the Director's Conference Room one week before Mendenhall's retirement. The meeting's attendees recommended to Ickes that the new

> **Director should be a geologist recognized for his integrity, high, unquestioned professional standing in Geology, proved administrative ability, and appreciation of technologic advancements and industrial needs. In addition, the State Geologists place a high value on the ability of the Director to cooperate with the States, and on such relationships today in war, and tomorrow in peace, such as the present Director has maintained.[75]**

Mendenhall, before departing as Director in 1943, appointed new Chiefs of two of the four operating Branches of the USGS, following similar action by Director Charles Walcott in 1907 before he left the agency to become the Smithsonian's fourth Secretary. The USGS Conservation Branch acquired a new Chief, following the death of Herman Stabler during November 1942. Hale Soyster, Chief of the Branch's Oil and Gas Leasing Division, replaced Stabler on February 8, 1943, and began reorganizing the Branch. John Northrop, who served as the Conservation Branch's Acting Chief during the interim, returned to his duties as Assistant Chief. Harold J. Duncan, who supervised the Branch's Rocky Mountain (later Northwestern) District, from its headquarters in Casper, Wyoming, succeeded Soyster in Washington. On March 18, Thomas Pendleton, Chief of the Topographic Branch's Photographic Mapping Section since 1941, became Chief Topographic Engineer, and John Staack, the former Chief, was reassigned as Assistant Chief. Charles H. Davey ended his tour as the head of topographic surveys in New England and came to Washington to lead the Branch's Photographic Mapping Section.

On April 9, 1943, President Roosevelt submitted the name of William Wrather to the Senate for confirmation as the sixth Director of the USGS. Wrather recalled his service as an assistant packer with a USGS field party in 1907 as "one of the most glorious summers I ever spent in my life";[76] after that experience, he completed his bachelor's degree and then studied law at the University of Chicago. Now, Wrather still served as Bateman's Associate Chief, at $6,500 per year, of the War Production Board's Metals and Minerals Division, but he had spent most of his career outside the Federal Government as a petroleum geologist in Texas.[77] Wrather, like Director George Otis Smith, was not a member of the National Academy of Sciences, but Wrather had presided over the American Association of Petroleum Geologists, whose Committee on Research he also led, and the Society

of Economic Geologists, whose journal *Economic Geology* he also helped to edit. In addition, Wrather had been vice president of the GSAm, served on the Executive Committee of the American Association for the Advancement of Science (AAAS), and chaired the AIMME's Petroleum Division. Although Wrather publically supported Herbert Hoover's candidacy for President and "disagreed personally with so many aspects of the New Deal," he agreed with Secretary Ickes' "expressed opinion that politics should not be a factor in choosing a Director for the Survey."[78]

Secretary Ickes, in announcing Wrather as his candidate for the Director's appointment, said that "Wrather's name had been proposed * * * by a number of prominent geologists and scientific organizations, including a committee of the National Academy of Sciences especially appointed for this purpose"[79] at Ickes' request. Ickes initially asked Donald H. McLaughlin, a geologist and mining engineer then serving as dean of the College of Engineering at Berkeley, to consider succeeding Mendenhall. When McLaughlin demurred, Ickes turned for advice to geographer Isaiah Bowman, JHU's president and NAS vice president since 1941. Bowman, former vice chairman of Roosevelt's Science Advisory Board, chairman of the National Research Council (NRC), and adviser to Secretary of State Hull, suggested that Ickes ask the NAS for a list of candidates. Beginning with Director King's appointment in 1879, Presidents and Interior Secretaries asked individual members of the NAS for their opinions on selecting scientists to lead the USGS, but Ickes' decision to accept Bowman's idea marked the initial request to the NAS as a body. Ickes asked the NAS to recommend persons "who had high administrative ability as well as sound scientific and technical competence."[80] The NAS appointed a committee chaired by Massachusetts Institute of Technology (MIT) economic geologist Warren J. Mead, Bowman's immediate predecessor as NAS vice president and coauthor with Charles Leith of a metamorphic-geology textbook published in 1915. Mead's committee included Bowman; Stanford geologist Eliot Blackwelder, part-time with the USGS during 1901–18; University of Chicago geologist Rollin T. Chamberlin, with the USGS during 1905–07; geophysicist Arthur L. Day, with the USGS during 1900–07 and then head of the Carnegie Institution of Washington's (CIW's) Geophysical Laboratory (GL) until 1936; the ever-present Leith; and Chester Longwell. Of at least four candidates, "Wrather was number one on the list provided by that body."[81]

It is also likely that the Petroleum Administrator for War and his Assistant Deputy Administrator influenced the Secretary of the Interior in his selection on April 7, 1943, of a petroleum geologist as President Roosevelt's nominee for USGS Director. The oil situation was becoming progressively more difficult, and Ickes claimed that America was "running out of oil."[82] DeGolyer came to Washington in 1942, toured Mexico for Ickes, and advanced to be Ralph Davies' principal aide as Assistant Deputy Coordinator (later Administrator). When Wrather's "friends on the outside of government"[83] also promised their support, he accepted Ickes' offer. Wrather saw the USGS directorship principally as an "opportunity to participate in a continuing program of geological research."[84] Ickes, in recommending Wrather to Roosevelt, also assured the President that Texas Senator Thomas Connally would not oppose Wrather's appointment. Roosevelt nominated Wrather on April 9. A week later, the AASG suggested that FDR's selection

> **should meet with hearty approval of geologists, for Mr. Wrather is well and favorably known throughout the profession, especially among those engaged in the search for petroleum, for that has been his principal field of activity. However, Mr. Wrather's interests and perceptions are broad enough to comprehend efficiently and sympathetically the entire scope of the work of the U.S.G.S.**[85]

Wrather's nomination joined the Senate's consent calendar and he was not asked to appear before a committee prior to his confirmation as the fifth Director

Geologist Julian Ducker Sears (1891–1970) joined the USGS full time in 1919 just after earning his Ph.D. at Johns Hopkins. He passed from studies of manganese ores in Costa Rica and Panama to investigations of regional geology, geomorphology, and energy resources in the Rocky Mountains of Colorado, New Mexico, Utah, and Wyoming. In January 1924, Sears succeeded Philip Smith as Administrative Geologist, and the Director's principal assistant, with full authority to act in duties the Directors specifically assigned. Sears also occasionally served as Acting Director and he represented the Director's Office on and chaired the Publications Committee from its founding in 1949. Sears requested and was granted a return to full-time research and publication in 1953. (Photograph from Bradley, 1973.)

of the USGS on May 3. Wrather took his oath of office 4 days later. Wrather, well aware that he "was the first Director to be chosen from outside the Survey,"[86] immediately asked Julian Sears to invite the Washington-area staff to headquarters to meet him as part of a day-long "open house." On July 10, Regional Geologist Harry Ladd, writing from Rolla to Josiah Bridge in Washington, noted Bridge's opinion that "Mr. Wrather is going to make a good Director and an aggressive one." Although Ladd added that he had "yet to hear a single item of unfavorable criticism about our new Director,"[87] members of the USGS Pick and Hammer Club reserved opinion until they resumed the club's annual shows.

By May 1943, coal rather than oil remained uppermost in Secretary Ickes' thoughts in his capacity as Solid Fuels Administrator for War. Hardly a week passed since the beginning of the year without some kind of labor crisis, but those in the bituminous-coal mines proved among the most troublesome. When 15,000 coal miners began a wildcat strike early in January, Roosevelt ordered them back to work. When the 2-year contract between miners and operators neared expiration in the spring, union chief John L. Lewis, who signed a no-strike pledge, challenged the economic-stabilization plan by demanding a $2-a-day increase in wages. The miners walked out again late in April and refused the President's request to return to work. On April 19, an Executive order changed Ickes' title from "Solid Fuels Coordinator for War" to "Solid Fuels Administrator for War," with commensurately greater authority and responsibilities.[88] On May 1, Roosevelt authorized Ickes to take over the mines if necessary. The next day, only 20 minutes before the President's scheduled radio address to his fellow Americans, Lewis ordered the miners back to work for 15 days. On May 3, Ickes proclaimed a 3-day week, which effectively raised wages; most of the miners returned to work by the next day. They struck again when the War Labor Board refused to authorize the increase in pay. On November 9, Ickes established Interior's Bituminous Coal Advisory Committee,[89] and the 78th Congress also intervened to try to assure continued adequate supplies of domestic coal. Senator Connally's bill, making a penal offense any strike or incitement to strike in the federally controlled war industries, passed the Senate by a large majority. The House considered an even harsher measure. Early in June, both houses approved the compromise Smith-Connally bill. Although Roosevelt vetoed the legislation, because it conflicted with labor's no-strike pledge, Congress passed the bill over his veto by a wide margin. In spite of the new War Labor Disputes Act[90] and the President's order to draft miners, the back-to-work movement yielded sporadic results.

As William Wrather became USGS Director, the House continued to consider the Interior Department's appropriation bill introduced in March for fiscal year 1943–44. The President's budget recommended an Interior appropriation two-thirds less than the funds approved on July 2, 1942, but the USGS share of $4,543,000 for 1943–44 represented just a 3-percent reduction. On March 26, 1943, Acting Director Julian Sears and Director Emeritus Walter Mendenhall led the USGS delegation to hearings held by the Subcommittee on Interior Department of the House Committee on Appropriations. Chairman Edward Taylor died in September 1941, and Oklahoma's Jed Johnson (Sr.) now led the subcommittee, whose new members included Michael J. Kirwan (D–OH), William F. Norrell (D–AR), and Benton F. Jensen (R–IA). At the Department's hearings earlier in March, Chairman Johnson asked the members of his subcommittee to "make every effort to cut these [Interior's] requests to the bone without seriously impairing the efficiency of the various departments and agencies."[91] He also refused to consider seriously "any and all new projects pending the duration of the war."[92]

The USGS hearings sparked no animated discussion; the subcommittee only nibbled at the budget items and recommended to the Committee on Appropriations that it approve nearly $4,475,000 for the USGS. On May 20, Johnson

reported to the House that his subcommittee urged "a total cut of only $72,702" because a "considerable portion of the work of the Survey is of direct value to the war."[93] The House passed the Interior Department's funding bill later that day, following the recommendations of Johnson's subcommittee as approved by the Appropriations Committee. President Roosevelt and Secretary Ickes sent to the Senate a request for supplemental appropriations for Interior that included $300,000 to enable the USGS to "conduct an intensive geologic search for supplies of petroleum and natural gas,"[94] $40,000 for the agency's supervision of mineral leasing, and more than $124,000 for investigations of Alaskan mineral resources. The USGS required additional monies for its work in Alaska because the WPB did not transfer funds to the USGS for war-minerals studies in the Territory as the House anticipated when its members held the budget hearings.

Director Wrather led the USGS delegation when the Senate subcommittee began its hearings about the agency's appropriations on May 28, 1943. Ohio's Harold Burton joined his Republican colleagues on Carl Hayden's subcommittee. The USGS request for an additional $300,000 for oil and gas investigations immediately became the center of interest. Wrather explained that appropriation would "enable the Geological Survey to resume its work in oil geology." When the war began, it seemed that all the oil required for a war of any duration was available and most USGS geologists were more urgently needed for work on strategic and critical minerals. Now it became apparent that every effort must be made to discover new fields. "New discoveries for the past several years," Wrather continued, "have been quite inadequate to replace current withdrawals and we are faced with the problem of finding large supplies of oil." The USGS, he added, must "resume its geologic investigations relating to oil."[95] That required additional funds and geologists. Senator Hayden questioned the amount requested for the new studies and quickly learned that the USGS originally asked for $1,065,000 for geologic surveys—including $675,000 for searches for new supplies and $390,000 for background studies to aid secondary recovery—an additional $175,000 for classifying the public lands, and an extra $164,725 for supervising mineral leases. The Bureau of the Budget approved only the $300,000 for searches for new supplies and $40,000 for monitoring mineral leasing. The question then became one of personnel. Were people available and, if so, could the USGS find and hire them? Support existed for the USGS contention that geologists were available despite personnel shortages. As for the agency's ability to employ them, Arthur Baker of its Fuels Section mused that "If you have the money, you can try."[96] If additional geologists were found and hired, the USGS expected to prevent those younger than age 37 from being drafted. In July, William Rubey reported that of the 230 short-term deferments requested for the 306 men in this category, representing two-thirds of the geologic staff, only 17 requests had been denied and 14 of those successfully appealed.

As the discussion progressed, Patrick A. McCarran (D–NV) who also chaired the Judiciary Committee and its Subcommittee on Appropriations for the Commerce, Justice, and State Departments, queried Wrather about past estimates of America's oil resources. McCarran, observing that in years past, investigations by the USGS and other organizations indicated that the United States has ample oil for any contingency, asked "Were all those studies erroneous? Were they all wrong?"[97] Wrather replied that

> **[n]obody seems to have anticipated a daily domestic production approaching 4,000,000 barrels of oil. I remember very well when I first heard of a million barrels a day. That seemed like an enormous figure. The needs of the Nation and our allies have gone up and up because of war demands until all previous figures have been completely outdistanced.[98]**

The Senate subcommittee asked the USGS to come back with a supplemental request that included the disallowed items. The revised request, presented on the next day of hearings, included $500,000 for oil and gas investigations, combining the search for supplies and geologic investigations as a basis for secondary recovery; $175,000 for classifying mineral lands; and more than $164,000 for mineral-leasing activities. The subcommittee wrestled with the problem of expanding USGS funding, not wanting to appropriate money that could not be used or to skimp. Its members finally recommended to their colleagues the increase of $500,000 to a total of $1,380,000 for geologic surveys, including those for oil and gas, and appropriations of $275,000, almost $170,000 more, for public-land classification and more than $550,000, up by about $211,000, for mineral-leasing supervision.

Discussion of the Alaskan supplemental request naturally included the question of developing oil in the Territory. Difficulties of transportation, remoteness, rigorous climate, and economic considerations thus far prevented any development of Alaska's oil potential. As in Hawaii, every drop of oil used in Alaska needed to be shipped into the Territory. Philip Smith, the Chief Alaskan Geologist, told the Senators on May 31 that "showings of oil"[99] were known to be present in the 37,000 square miles of Naval Petroleum Reserve No. 4, where he personally conducted some of the exploratory work some 20 years earlier, but that its development posed serious problems involving personnel and equipment. Smith pointed out that attempts to explore for, locate, and develop oil fields in NPR–4 would face the same problems that the Army encountered in initiating similar work in adjacent Canada, in an area of comparable geography and geology. Following Lt. William Foran's recommendation, a USBM party, including geophysicist Henry R. Joesting (of the Alaskan Territorial Department of Mines) and an Army Engineer Captain, traveled by light plane to NPR–4 and other areas in Arctic Alaska late in the summer of 1943. "The group visited the known seepages, including those at Cape Simpson, * * * [and] three [new] small seepages near * * * Umiat,"[100] on the Colville River, about 130 miles to the southeast.

The increasing demand for crude oil encouraged the Senate subcommittee and the whole Senate to approve the additional funds for work in Alaska. The conference committee compromised on a USGS appropriation that included $1,187,500 for geologic surveys, $307,500 more than the House bill, $150,000 for Alaskan mineral resources, up by $76,000, $224,00 for public-land classification, an increase of $130,000, and $475,000 for mineral-leasing supervision, up by $145,000. In the bill approved on July 12, 1943, the USGS received just over $5,143,000 in direct appropriations,[101] or about 12 percent more than the amount in the President's budget. With transferred and repaid monies, the USGS received in fiscal year 1943–44 a total of some $11,585,000, a $456,000 increase over fiscal 1942–43, for salaries for and operations by its staff of more than 2,400 full-time people and another 500 seasonal workers.

As Wrather began to lead the USGS, the Allies' campaign in North Africa neared its end, and in the Pacific, their forces regained the western Aleutians and prepared to continue advances in New Guinea and the Solomons. Hitler ordered an ailing Rommel out of Tunisia in March, but the Führer could not save the Axis ground troops there. On May 7, American ground forces, now under Major General Omar N. Bradley, captured Bizerte. General Montgomery's British units took Tunis. The Luftwaffe pulled out and Italo-German resistance ended on May 13; 250,000 Axis troops surrendered, a loss almost as great as that at Stalingrad. Two days earlier, American and Canadian forces landed on Attu in the Aleutians. The Allied soldiers repelled a ferocious suicide charge and completed the island's recapture on May 29 but at the cost of nearly 1,700 casualties. From now-isolated Kiska, the Japanese secretly and successfully evacuated their garrison on July 29. The

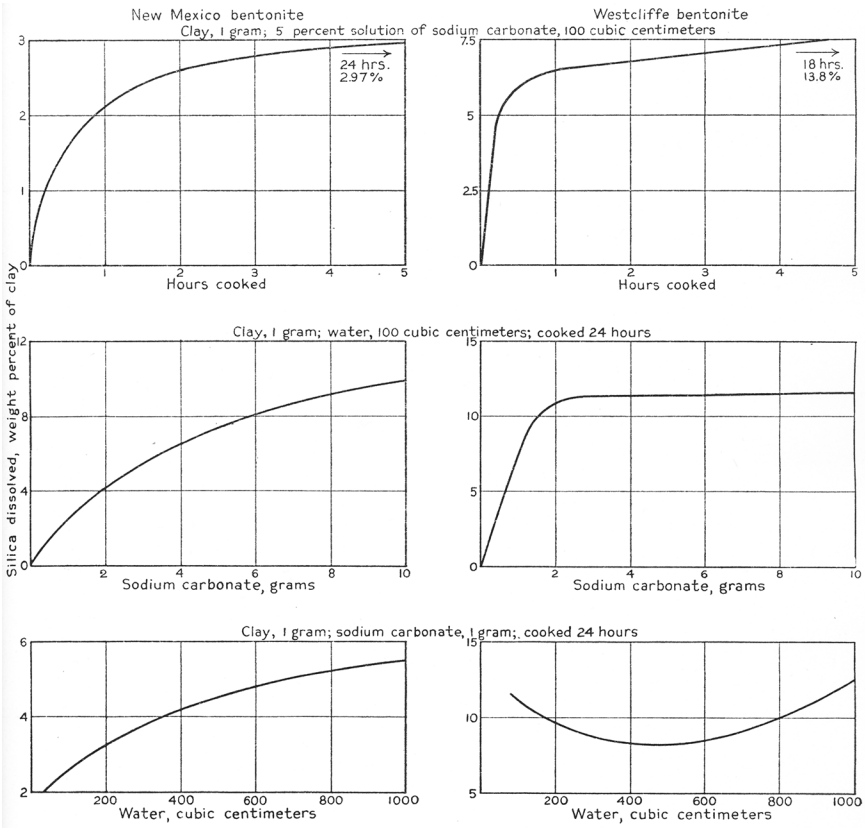
entire Aleutian chain returned to American control when American and Canadian forces occupied Kiska on August 15.

Wrather knew that the USGS was "committed to a war program, and its work was pretty well defined as long as the war lasted."[102] The Geologic Branch received a total of $2,624,000 in fiscal year 1943–44, which was $708,000 more than in the previous year. The USGS geologic program took on another new orientation, drawing on the year's total funds for geologic surveys of nearly $1,853,000, some $678,000 more than the past year. The Fuels Section's staff grew from fewer than 20 to 100 persons, justifying Arthur Baker's optimism about its ability to hire oil geologists. Hugh Miser, in meetings with a number of petroleum-industry people, determined that they wanted as aids in developing new supplies the rapid publication of USGS regional stratigraphic and structural studies as a framework for their own detailed investigations. Fuels Section personnel began in 23 States these new regional studies of the distribution of potentially oil-bearing formations and broad areas where conditions might have led to accumulating petroleum. These investigations targeted areas in California, the Rocky Mountains, the northern Great Plains, the Mid-Continent, the Mid-South, the Gulf of Mexico Coast, the Michigan Basin, and the Appalachians. Before the end of the fiscal year, a newly devised and more rapid method of publication led to the results of these studies being issued in 10 preliminary Oil and Gas Investigations Maps (OM) and Charts (OC), beginning with Thomas Hendricks' [OM]–1, on the geology of the Black Knob Ridge area in southeastern Oklahoma, and Ralph Stewart's [OC]–1, on a biostratigraphic study of the Coalinga anticline in central California. Other geologists mapped sands and asphalt deposits in Oklahoma and California deemed to have considerable potential as sources of petroleum and made preliminary examinations of deposits in other States in cooperation with the USBM and the PAW. Fuels Section geologists continued to investigate coal deposits, mainly in the Western States, where expanded war-related activities increased demands for coking and steam coal. They also undertook detailed mapping in Alabama, Colorado, Nevada, and Oregon, in conjunction with exploratory drilling by the USBM, and also examined other coal deposits in Oklahoma and Washington.

Geologic Branch personnel also continued strategic-mineral investigations in the southeastern and western manganese districts; California's mercury deposits; tungsten districts in California, Idaho, and Nevada; and the vanadium districts of southeastern Idaho and the Colorado-Utah area. These studies drew on the $771,000 (which was $30,000 more than in fiscal year 1942–43), provided by direct, deficiency, and transfer appropriations. The growing success of the Allied antisubmarine campaign during the winter of 1942–43 made it possible to import larger quantities of some essential minerals. By the fall of 1943, as Alfred E. Eckes, Jr., and other historians observed, the demands for domestic sources of some of these minerals began to fall, but domestic reserves of some of the common metals were being seriously depleted. In response, the USGS gradually shifted more of its geologists to work in districts with good prospects for locating new deposits and developing significant reserves of these common metals.

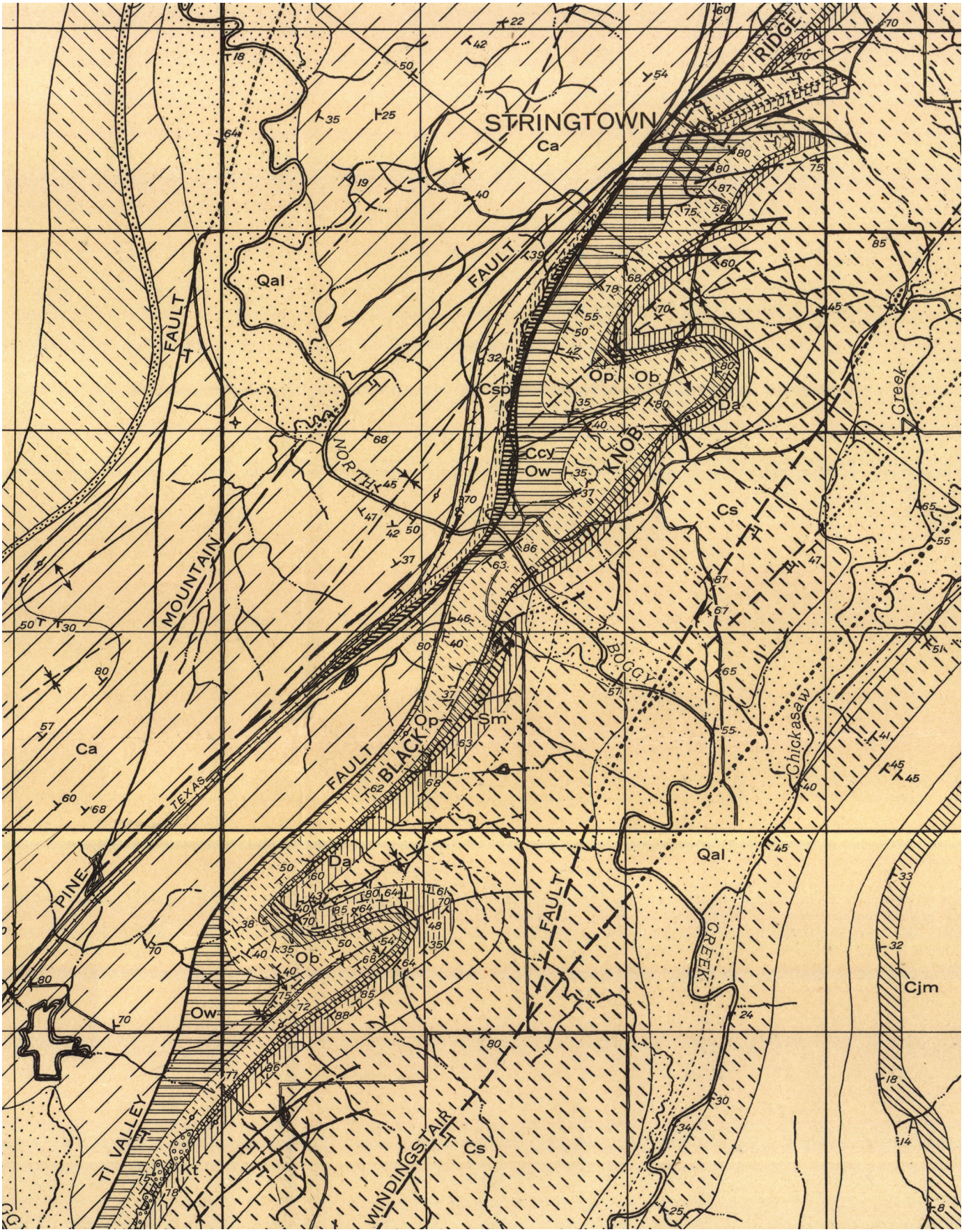
Resources of iron ore, aluminum ore, and fluorspar by now were matters of grave concern. The Geologic Branch carried out studies of iron-ore deposits in more than 50 separate areas in 20 States. Harold James and other Branch geologists began a long-range program in northern Michigan, including the Iron River and Crystal Falls districts, to determine the quantity and distribution of undeveloped low-grade ores and try to discover additional high-grade ores beneath glacial drift. At the same time, curtailed shipments from the Lake Superior region emphasized the need for further development of resources in the Eastern and Southern States; work in New York concentrated on deposits in the Adirondack and Highland regions. The growth of the steel industry in the West, including the establishment of federally aided plants, called for intensive efforts by the USGS, particularly in

This diagram by mineralogist Perley G. Nutting shows the amount of silica from six bentonites dissolved by dilute acid and alkaline solutions. Clays are used widely in ceramics, decolorizing oils, drilling muds, fertilizers, fungicides and insecticides, molding sands, and water softeners, and they are catalysts in producing fuels from petroleum. Nutting served with the National Bureau of Standards and Eastman Kodak before joining the USGS in 1925, where he studied the identification, distribution, physico-chemical properties, products, and uses of absorbent (bleaching) clays to determine the most economical treatments. Low-grade or impure clays, he found, could not be upgraded by chemical means. (From Nutting, 1943a, pl. 13; see also Nutting, 1943b.)



the southeast Utah area considered the most urgent by the Metals Reserve Company. Aided by $317,000 transferred from the USBM from its $1,860,000 for work on bauxite and related deposits, Preston Cloud, Jr., and other Branch geologists continued detailed surveys of bauxite in nine areas in the Gulf of Mexico Coastal Plain. The cooperative drilling program by the USBM and the USGS in Saline and Pulaski Counties, Arkansas, delimited more than 11 million tons of bauxite of commercial grade. Their colleagues conducted nationwide searches for other sources of aluminum and for magnesium and included studies of alunite, high-alumina clay, brucite, dolomite, and magnesite. As war uses of fluorspar nearly depleted the known resources, the three USGS parties established in 1942 continued work in the Kentucky-Illinois district and Tennessee, in Colorado, Idaho, Washington, and Wyoming, and in Arizona, New Mexico, and Texas. A new fourth party began studies in California, Nevada, and Utah, and temporary groups initiated work in northern Idaho, northwestern New Mexico, and Montana.

The status of copper, lead, zinc, and other commodities also became critical, and some substitutes were used. To save copper for war use, in October 1942 the WPB ordered U.S. gold mines closed for the duration and the U.S. Mint began producing, in February 1943, the zinc-coated steel pennies authorized by statute in December 1942. USGS geologists began or renewed studies in virtually all of the copper-mining districts of the country, including the Foothills Belt of California, Globe in Arizona, and areas in Michigan. They also initiated lead-zinc projects in areas in a dozen States, including the Metaline district in Washington, the Pioche and Goodsprings districts in Nevada, Eureka in Utah, and those in southwestern Wisconsin and eastern Tennessee. More than 250 pegmatite deposits containing sheet mica, beryllium, tantalum, lithium, and feldspar were examined in 13 different States, after which the USGS recommended several for additional exploration by the USBM. Other commodities investigated included asbestos, corundum, graphite, potash, quartz crystals, talc of insulator grade, and vanadium. Work also progressed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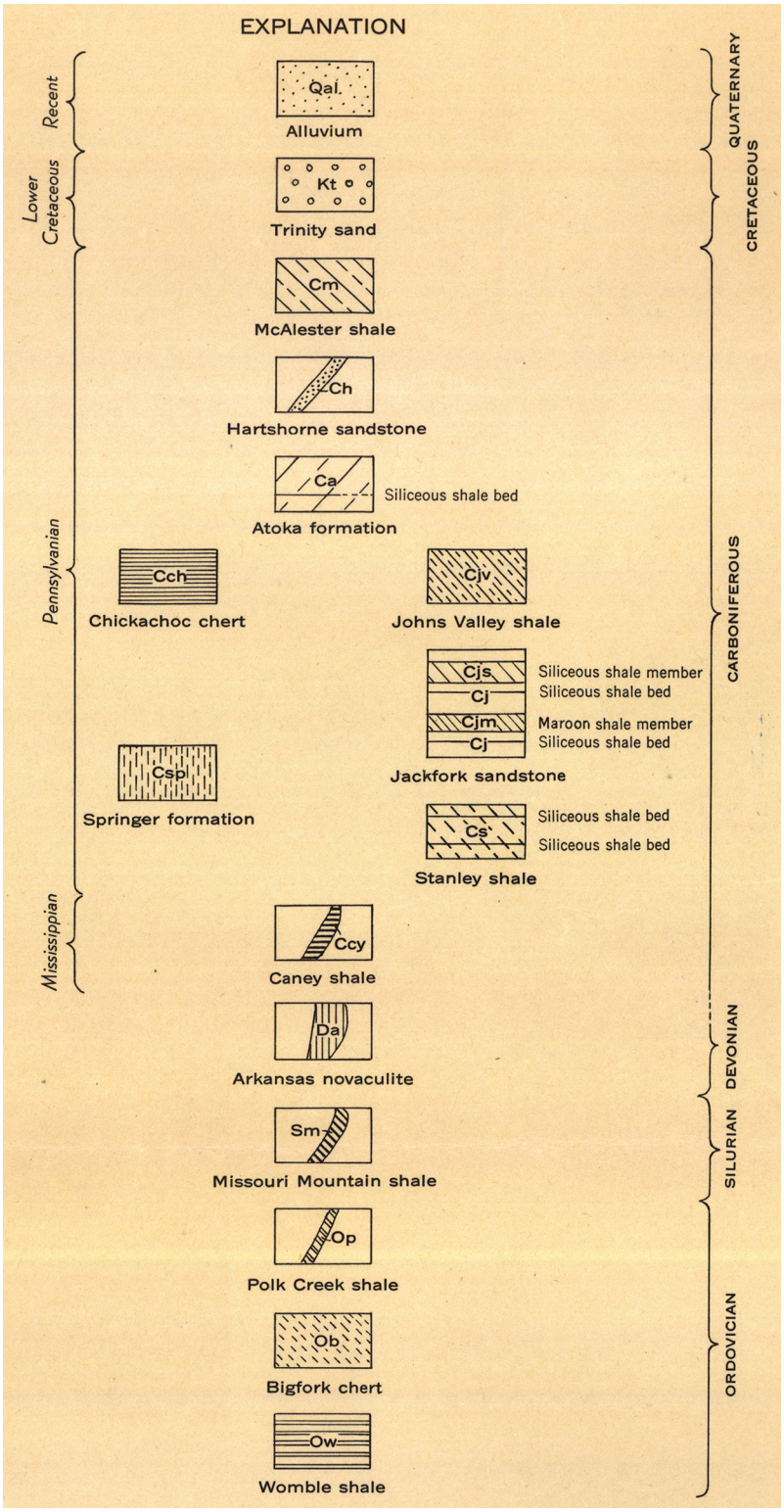
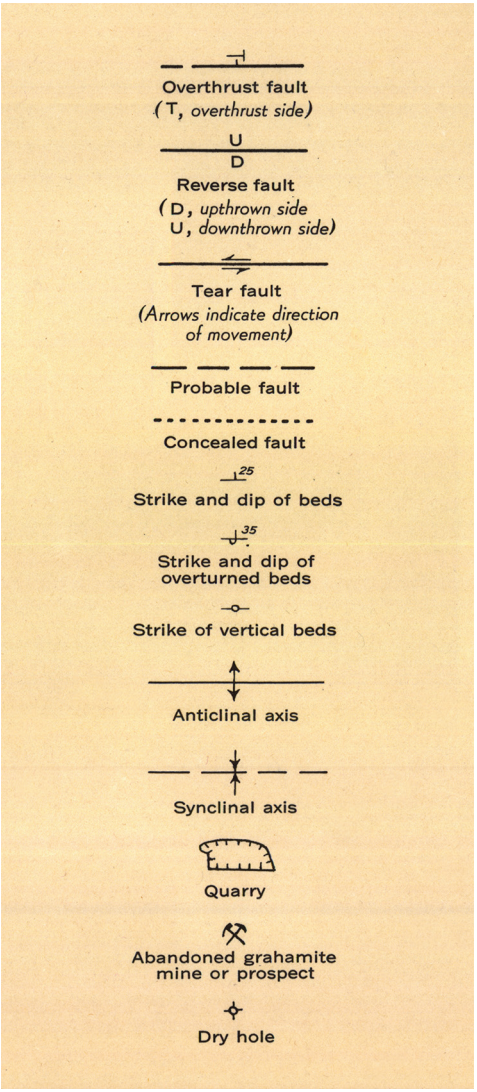
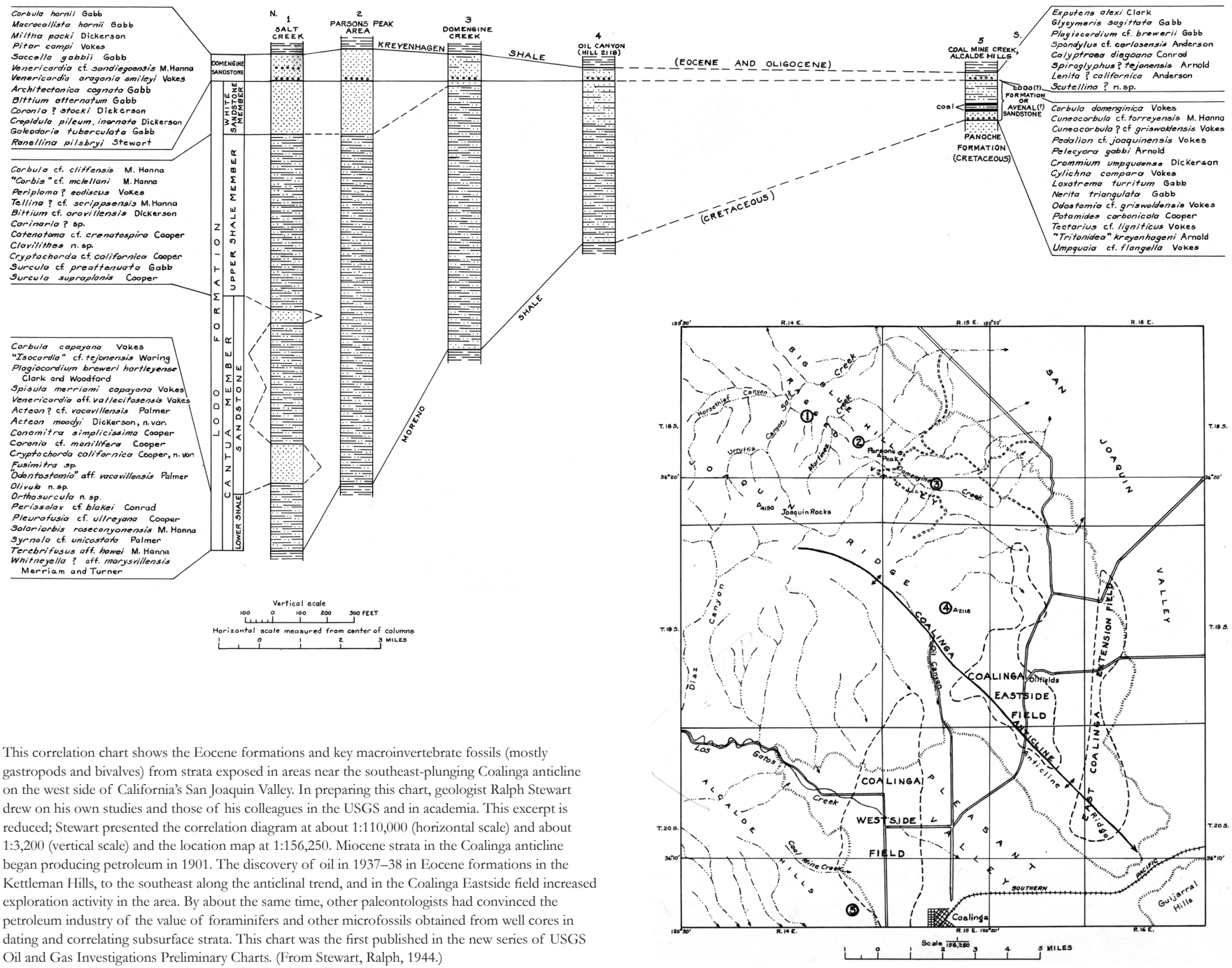




This portion of the geologic map (at 1:42,240 and originally on white stock) of the Black Knob Ridge area (facing page), in Oklahoma's Atoka County, shows the major folds and faults that divided the area, located at the western end of the Ouachita Mountains, into several structural blocks. The east-to-west increase of carbon ratios in the adjacent Arkansas-Oklahoma coal basin and the equivalent decrease in "the porosity of potential oil bearing horizons" in deep wells east of the coal basin's oil fields indicated that the best petroleum targets would be the anticlines "adjacent to the Choctaw fault [just west of the area shown in this part of the map] * * * near its west end, or the part in the Black Knob Ridge area." Each square of the map's grid represents a section (1 square mile) of the cadastral survey. The map sheet also contained an explanation (above), a geologic section (along the northwest to southeast line), text, and a correlation diagram. This map was the first published in the new series of USGS Oil and Gas Investigations Preliminary Maps and reflects the increased emphasis by the USGS on petroleum geology after Secretary Ickes chose William Wrather to succeed Walter Mendenhall as Director. (From Hendricks, T.A., 1943.)

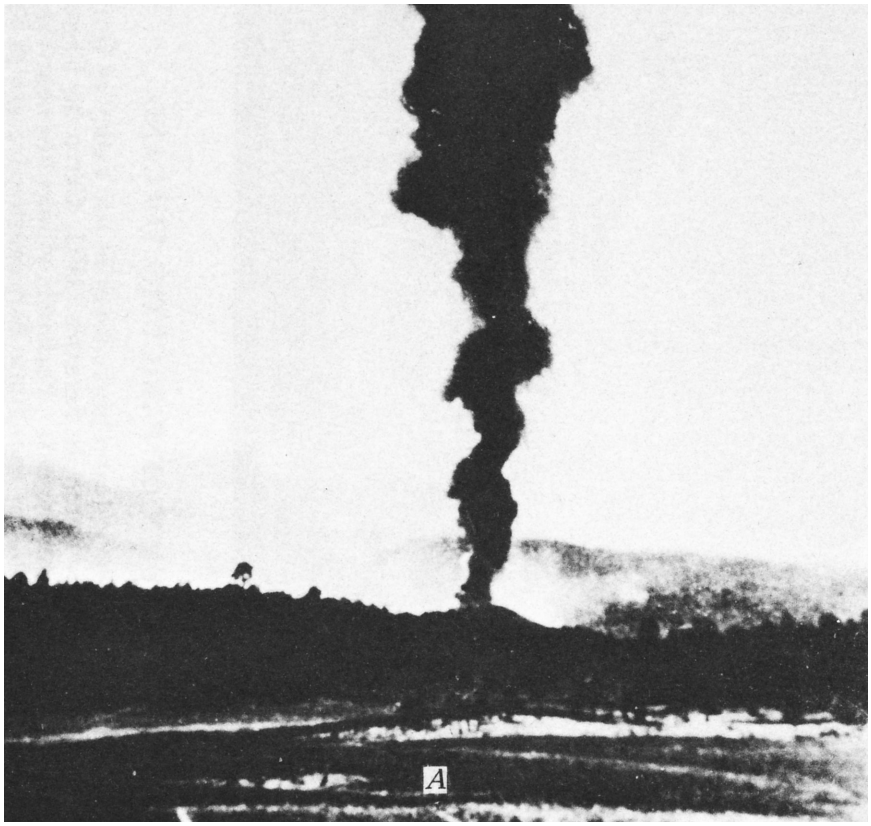


This correlation chart shows the Eocene formations and key macroinvertebrate fossils (mostly gastropods and bivalves) from strata exposed in areas near the southeast-plunging Coalinga anticline on the west side of California's San Joaquin Valley. In preparing this chart, geologist Ralph Stewart drew on his own studies and those of his colleagues in the USGS and in academia. This excerpt is reduced; Stewart presented the correlation diagram at about 1:110,000 (horizontal scale) and about 1:3,200 (vertical scale) and the location map at 1:156,250. Miocene strata in the Coalinga anticline began producing petroleum in 1901. The discovery of oil in 1937–38 in Eocene formations in the Kettleman Hills, to the southeast along the anticlinal trend, and in the Coalinga Eastside field increased exploration activity in the area. By about the same time, other paleontologists had convinced the petroleum industry of the value of foraminifers and other microfossils obtained from well cores in dating and correlating subsurface strata. This chart was the first published in the new series of USGS Oil and Gas Investigations Preliminary Charts. (From Stewart, Ralph, 1944.)

in the Almaden and Oat Hill mercury districts in California and on the tungsten deposits in three districts—Pine Creek in California, Yellow Pine in Idaho, and Mill City in Nevada.

John Dorr, Montis Klepper, William Pecora, Ralph Roberts, Frank S. Simons (Jr.), and other USGS geologists continued or began investigations of strategic and critical minerals in nine Caribbean and Latin American countries during fiscal year 1943–44, drawing on the $74,000 transferred by the State Department or working on detail to the Board (later Office) of Economic Warfare, and the latter's successor, the Foreign Economic Administration (FEA), founded in the Office for Emergency Management by Executive order on September 25, 1943.[103] The FEA entirely sponsored similar investigations, supervised by Alan Bateman, of the mineral resources of Colombia, Costa Rica, Guatemala, Honduras, Nicaragua, and Panama by Earl M. Irving, Chief of the FEA's Minerals and Metals Mission to Central America since 1942, and USGS geologists on detail to the FEA or others employed by that agency. Irving spent the months between September 1942 and August 1945 studying copper deposits in Guatemala and Costa Rica and chromite and iron occurrences in Guatemala. From January 1944 through August 1945, Irving also worked with Roberts on antimony, copper, and iron in Guatemala. Roberts investigated iron, mercury, and silver in Honduras during 1943. Simons studied manganese in Panama between July 1943 and June 1944.

The USGS also continued to draw on the Smithsonian Institution's staff for its strategic-minerals work in Latin America. William Foshag pursued his cooperative studies of mercury, tin, tungsten, and other strategic minerals in Mexico during 1943, aided by USGS geologists Carl Fries, David Gallagher, James McAllister, and Donald White and USGS topographer Kenneth Segerstrom. These geologists all gained additional experience during the development of a new volcano. On February 20, 1943, after 2 weeks of seismic tremors, a volcanic eruption began in a cornfield just southeast of Parícutin Village, some 20 miles from Uruapan in the



This view looking southwest shows Parícutin Volcano on February 21, 1943, one day after its eruption began in a cornfield just southeast of Parícutin Village, some 20 miles from Uruapan in the State of Michoacán and about 200 miles west of Mexico City. In this short time, the new cone (just to the right of center at the base of the eruptive column) reached a height of nearly 100 feet and grew rapidly thereafter as the volcano ejected bombs, lapilli, and lava. Ezequiel Ordóñez, Chief Geologist of Mexico's Comisión Impulsora y Coördinadora de la Investigación Científica, began photographing the volcano on February 24 and, with USGS geologist Donald White, began studies of the volcano on March 25. (Photograph by Salvador Ceja, from Foshag and González-Reyna, 1956, pl. 17*A*.)

State of Michoacán, and about 200 miles west of Mexico City. Ezequiel Ordóñez, Chief Geologist of Mexico's Comisión Impulsora y Coördinadora de la Investigación Científica, and Donald White reached the site on March 25. Through the rest of 1943, Foshag, his USGS colleagues, the Smithsonian's G. Arthur Cooper, the American Museum of Natural History's Frederick H. Pough, Ordóñez, Jenaro R. González-Reyna, and Adán Pérez-Peña briefly and intermittently observed Parícutin spew ash, gas, and lava as the volcano rose above the plain to an elevation of nearly 1,500 feet.

In the first half of 1943, while Parícutin continued to grow, Bill Bradley's Military Geology Unit responded to increasing requests for its services, supported by an additional $85,000 received from the Army Engineers. By the MGU's first birthday in June, Bradley's staff numbered 46 people, including groundwater experts, whose studies Charles Theis and his successors coordinated beginning in February. Among them were specialists on the USGS permanent staff, when-actually-employed academics, members of industry, and war-service appointees. They worked in close quarters in what they called the "Dungeon," a part of the basement of Interior's "old" building. The cramped offices and long hours spent on rush jobs, often completed from inadequate information, led not to serious acrimony but to good morale. The MGU's motto, "In military geology, any intelligent quick action is better than delay in search of the ideal,"[104] was burlesqued internally as "Don't think—act!"[105]

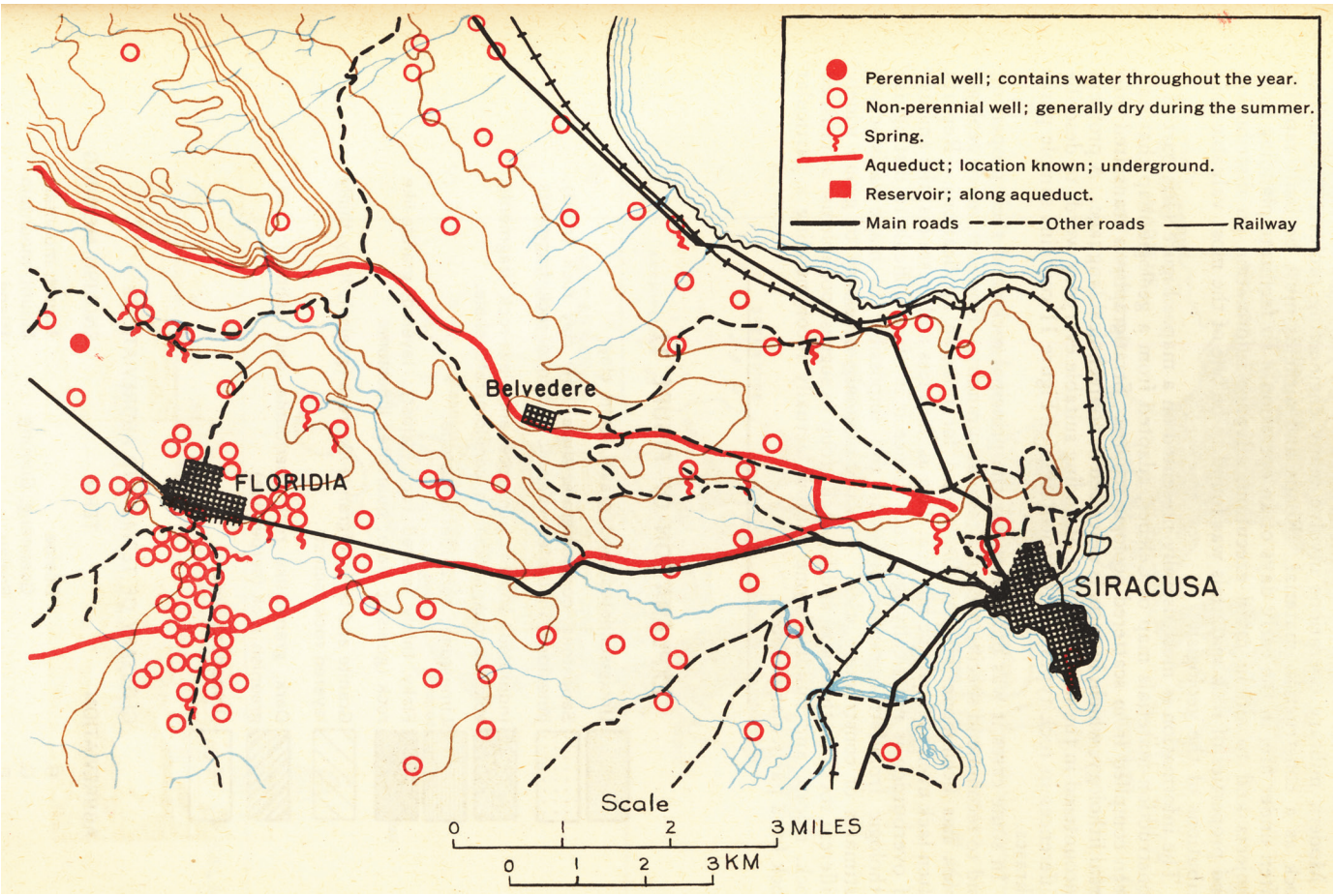
During calendar 1943, the Military Geology Unit completed for the Army Engineers more than 50 numbered SES reports and other unnumbered compilations. These reports provided terrain and other information about Afghanistan, Albania, Bulgaria, China and Siberia, Corfu, Corsica, Crete, the Dodecanese Islands, France and its Mediterranean coast, French Indochina, Greece, Iraq, Italy (Naples and areas south to Calabria, Rome, and the Po Valley), Java, the Mediterranean, The Netherlands and its portion of New Guinea, Nigeria, Norway, Palestine, Sicily, Spain, Sumatra, Transjordan and other countries in the Levant, Turkey, and Yugoslavia. Topical studies by geologists and hydrologists included those about permafrost, among them an overview in SES 62 by Stanford's Siemon Muller and a look by Theis, while on detail to the Army Engineers during October 1943–March 1944, at the involved thermal processes to aid the search for water supplies for bases along the new Alaskan-Canadian (Alcan) Highway. The MGU also finished assessments of seven possible airfield sites in the Solomons and the Bismarcks, with feasible lengths of runways, and commodity targets for bombing by the U.S. Army Air Forces.

At Casablanca in January 1943, the Combined Chiefs of Staff approved Sicily as the next objective in the Mediterranean. On 25 March 1943, Colonel Garrison H. Davidson, Chief Engineer of Lt. General George S. Patton, Jr.'s I Armored Corps (later 7th Army), began planning for engineer operations during the U.S. landings near Palermo. Operation Husky, the invasion of Sicily, involved 175,000 British, Canadian, and American troops of General Harold R.L.G. Alexander's 15th Army Group. To provide strategic intelligence for Husky, General Eisenhower's Allied Forces Mediterranean headquarters, having moved to Algiers, requested the Chief of Engineers and the MGU to deliver a comprehensive report on Sicily by July 1. General Eisenhower rejected as too risky the suggestion by General Marshall that Patton's troops and those of General Montgomery's British 8th Army (also in 15th Army Group) go ashore in northeastern Sicily near Naval Base Messina-Reggio and isolate the island's Italo-German garrison of some 260,000 regulars and reserves.

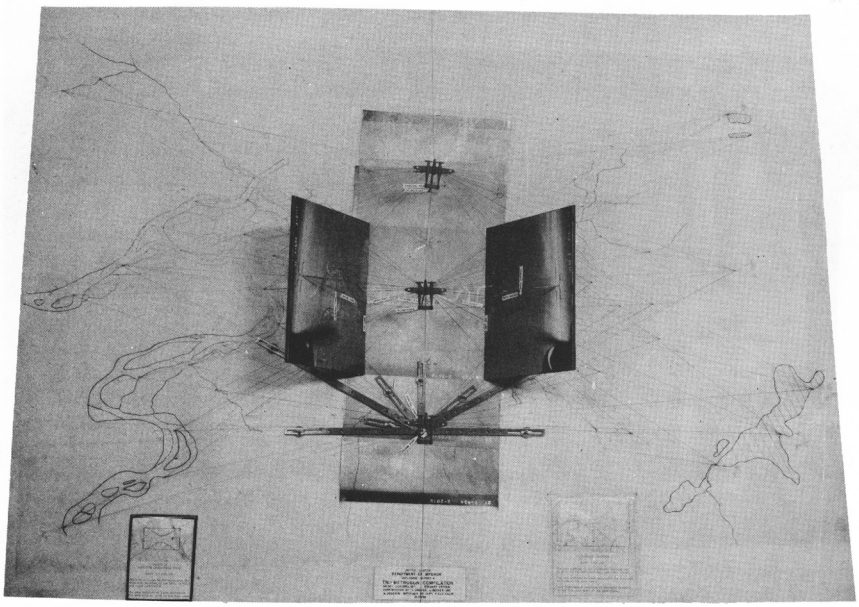
The MGU, building on Marcus Goldman's 30-page report on Sicily, began the terrain-intelligence folio about that island by preparing preliminary reports on the aqueducts and water supplies of Messina and other locales. On May 9, 1943, the Army Engineers advanced the due date for the MGU's Sicily report to June 1.

The MGU and the Army Map Service (AMS) split the time available. Beginning on May 10, 28 members of the MGU compiled data about airfield sites, construction materials, geology, mineral resources, seasonal states-of-the-ground, terrain appreciation, and water resources. The MGU presented its SES 50, a 56-page compilation, accompanied by a bibliography and maps at a scale of 1:650,000, to the AMS on May 20. The AMS printed 600 copies of the folio and delivered them on time to the planners at the Survey Directorate in Algiers. Topographical-engineer units reproduced some of the folio's detailed maps for issue to the 15th Army Group's principal combat units. The MGU then produced separate, more-detailed folios for Sicily's western and eastern halves as parts 2 (83 p.) and 3 (101 p.) of SES 76. These folios included terrain-water-airfield maps at 1:100,000, road construction and maintenance maps at 1:200,000, bibliographies, photographs, and physiographic (later termed "terrain") diagrams by Philip King. The MGU also completed a larger report on Sicily's aqueducts as part 4 of SES 76 and its maps at 1:1,000,000. On June 13, Colonel Davidson issued a complete engineer-operations plan for the 7th Army's invasion, now reoriented to beaches (part 1) on Sicily's southwestern coast.

As the Army pushed ahead on Operation Husky, total funds for the Alaskan Branch in fiscal year 1943–44 fell by $360,000 to about $889,000. The Branch's direct and deficiency appropriations grew by $102,000, but the OEM's contribution ended and the War Department's transfer sum decreased by more than $298,000 to $712,000. All of the Branch's new field projects during the 1943 season gathered information on mineral resources. In the southeastern part of the Territory, George C. Kennedy, Matt S. Walton, Jr., and other USGS geologists sought ores of chromium, molybdenum, and nickel and assessed copper-iron basic intrusive and



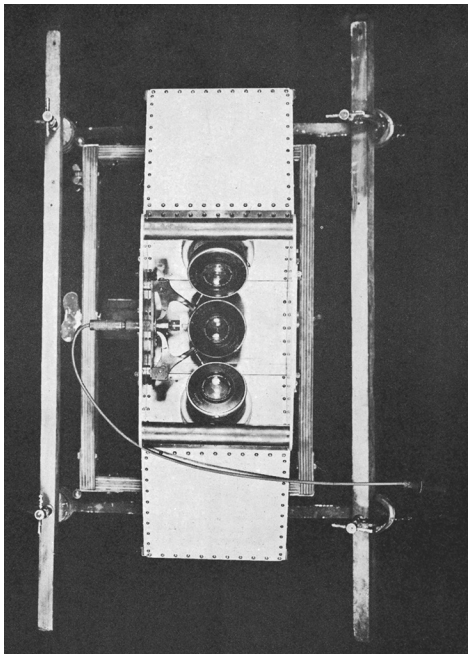
This water-supply map (originally at 1:1,000,000) of the Siracusa (Syracuse) area, derived from a 1:100,000 map published in 1943, shows the general distribution of aqueducts, reservoirs, springs, and wells (printed in red), and streams (blue) as compiled for the Allied invasion of Sicily. In May 1943, the USGS Military Geology Unit's Strategic Engineering Study 76 presented analyses of Sicily's landing beaches (part 1), terrain intelligence on the western (part 2) and eastern (part 3) halves of the island, and its aqueducts (part 4). Parts 2 and 3 contained maps and charts of terrain appreciation, construction materials and fuels, roads and maintenance, possible airfield sites, and Italian ground photographs taken in the 1920s and 1930s. (From U.S. Geological Survey and U.S. Army Corps of Engineers, 1945, fig. 10; also published in Nelson, C.M., and Rose, E.P.F., 2012, fig. 4.)



This model of trimetrogon aerial photogrammetry shows the method that was cooperatively developed during 1941–42, by personnel of the U.S. Army Air Forces and an eight-man USGS team led by Gerald FitzGerald, to economically and quickly compile planning and operational aeronautical charts and other small- to medium-scale strategic maps. Images taken by a group of three cameras, equipped with wide-angle "metrogon" lenses and (within the assembly) oriented vertically (first camera) and at 60 degrees oblique (second and third cameras), were processed by plotters, intersectors, angulators, and other instruments to produce the maps. Large parts of Alaska and Antarctica later were mapped at reconnaissance scales by this method. (From Thompson, 1958, fig. 11; see also FitzGerald, 1944b, for trimetrogon-photographic mapping, and 1944a, for aeronautical charts.)

magnetic rocks. Don Miller, Robert F. Black, and Ralph E. Van Alstine searched intensively for copper deposits in the Nizina and Kotsina-Kuskulana districts, east of the Copper River. In the Cook Inlet-Alaska Railroad belt, other USGS geologists examined tungsten deposits, lead and zinc ores, chromite, and portions of coal fields. USGS geologists also made detailed studies of mercury deposits in the Kuskokwim region. Investigations of tin resources continued on the western Seward Peninsula, and preliminary work began on tungsten deposits near Nome and Solomon. Field parties also looked at occurrences of asbestos, graphite, and quartz crystals.

During fiscal year 1943–44, the USGS Topographic Branch continued to be largely engaged in producing maps of both domestic and foreign areas for the War Department, which provided about $1,739,000, a reduction of nearly $460,000 from the previous year. Funds supplied by States, counties, and municipalities and those transferred from other Federal agencies decreased slightly, but miscellaneous repay monies rose by $36,000. Drawing on total funds of almost $2,940,000, Branch personnel carried out field surveys in 34 States and Puerto Rico; agencies in 17 of the States and Puerto Rico cooperated in the work as did the TVA and the War Department. USGS topographers mapped nearly 18,560 square miles in the States. Of the 253 quadrangles completed and the 90 others in progress, 279 were within the War Department's strategic areas.[106] The Section of Photographic Mapping also produced topographic maps of areas in the United States covering approximately 7,120 square miles and planimetric and other base maps of some 13,900 square miles. By October 1943, less than half of the United States, Wrather told Ickes, was plotted comprehensively. Fortunately, most of the areas that needed additional mapping lay in the central and western States. In several strategic areas along the Nation's coastlines, military requirements yielded a 60-percent increase over fiscal 1942–43 in the number of square miles of mapping produced monthly by Branch employees. Crediting advances in photogrammetry, Wrather emphasized that the technique was only about one-third as expensive as and from three to five times faster than prewar methods. Wrather predicted significant postwar uses for photogrammetry, beyond those demonstrated by the TVA–USGS collaboration, in drainage enterprises, erosion control, flood-control planning and execution, forest



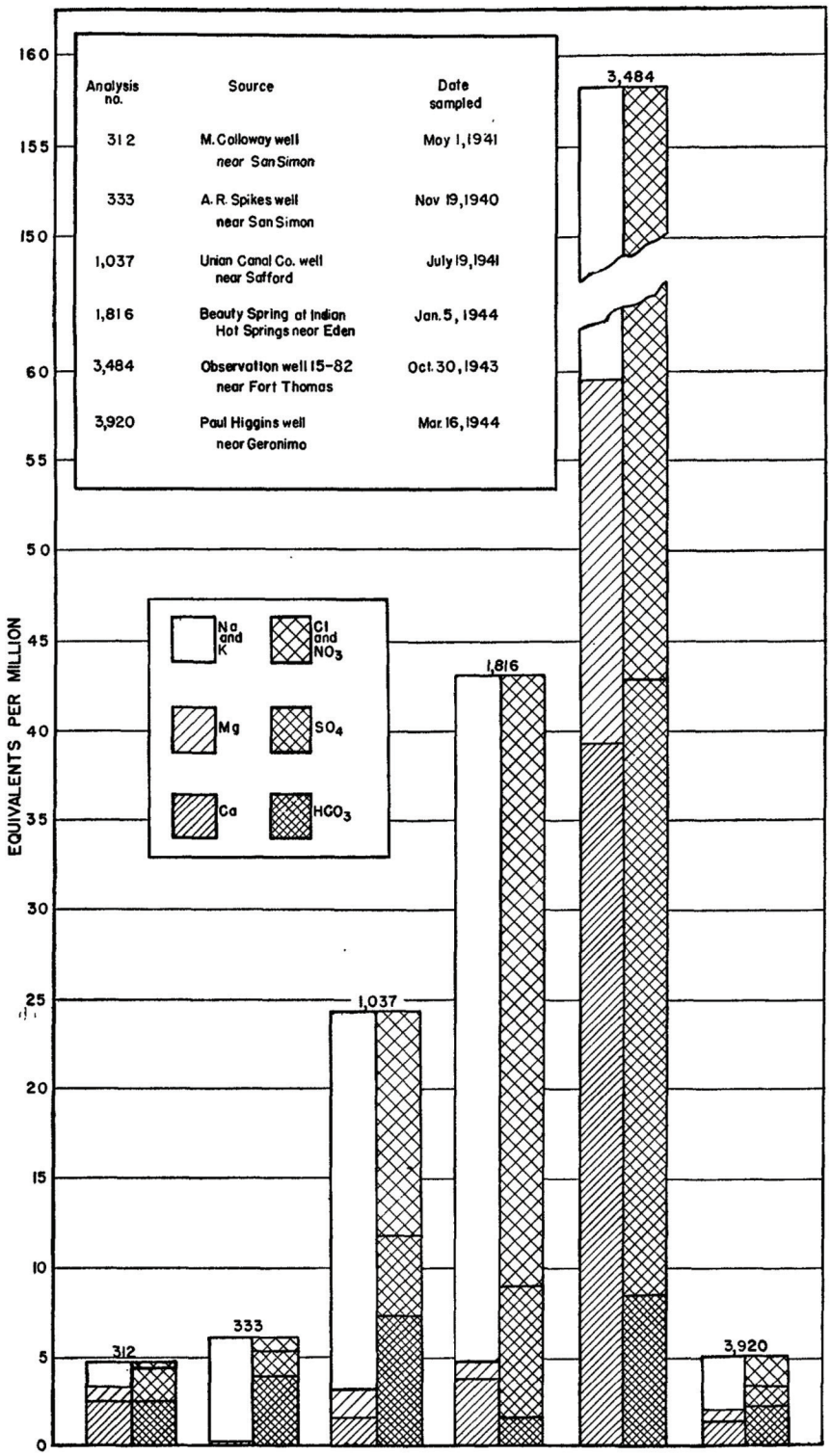
The tri-lens camera shown here (rotated 90 degrees from the horizontal) is an improved version of the one designed in 1916–17 by USGS topographer James Warren Bagley (1881–1947), aided by his agency colleagues John Mertie and Fred Moffit, and developed by the Army Engineers. The camera's base supported "three compartments and a magazine capable of carrying a roll of film 400 feet long." As mounted in aircraft, the optical axis of the central compartment's lens (f/6.3, 6-inch focal length) pointed down; the side compartments' lenses (f/6.3, 7-inch focal lengths) were tilted at 35 degrees to the central lens' axis. Only the shutters between the lenses operated automatically. The camera's field "was roughly three times the flight altitude. Later, cameras of this general design were built with 4- and 5-lens combinations." This assembly subsequently formed the model for the metrogon-lens camera used in trimetrogon photography and mapping in the 1940s, as shown and described on the facing page. (Quotations and photograph from Thompson, 1958, p. 5, 6, and fig. 3; for a summary of Captain [later Lt. Colonel] J.W. Bagley's career with the USGS and the Army Engineers, see Bagley, C.T., 1996.)

administration, highway location and construction, mineral and soil surveys, power and irrigation projects, and river and harbor improvements.

The USGS mapping program carried on at the request of and with funds supplied by the USAAF, under the auspices of the Alaskan Branch, proved so useful that it gradually expanded to include mapping large strategic areas in other countries. The Topographic Branch withdrew many engineers from fieldwork and assigned them to the Section of Photographic Mapping to revise, by means of aerial photographs, maps of foreign territory showing about 26,000 square miles and to compile contour maps from older hachured maps totaling some 13,000 square miles. Branch personnel assembled in changed format and redrafted existing maps of an area of 43,000 square miles. They completed for use by the USAAF a considerable number of shaded-relief maps at 1:1,000,000 and larger scales. Branch members also compiled from aerial photographs planimetric maps showing nearly 5.5 million square miles and topographic maps depicting 500,000 square miles. These maps initially included aeronautical-approach charts for the continental United States; then the geographic scope was expanded to comprise target charts for and revisions from aerial photographs of parts of Europe and areas in the Pacific for the USAAF and the AMS. Work also continued on five sheets of the 1:1,000,000-scale International Map of the World, of which the Chicago sheet neared publication.

Funds for water-resources investigations by the USGS during fiscal year 1943–44 totaled more than $3,542,000, including about $1,437,000 in the Interior Department appropriations bill and two supplemental bills, cooperative funds of $1,152,000 supplied by State, county, or municipal agencies, and nearly $954,000 from other Federal agencies. The supplemental legislation that provided an additional $90,000 for gaging streams also raised the sum provided exclusively for State-municipal cooperation from $975,000 to $1,065,000. Of the total from other Federal agencies, nearly $712,000 came from the War Department; the TVA added $59,500, the Defense Plant Corporation transferred nearly $58,000, and the State Department provided $50,000. The number of requests from industrial and military sources for special reports on water supplies continued to increase; the Water Resources Branch produced more than 5,000 such reports during the year in response to specific queries. At the same time, enlistments in and drafts for service in the armed forces depleted the Branch's workforce, and the remaining employees had little time for other efforts. Some of the experts who now entered military service continued to be assigned to Army water-supply units in the theaters overseas.

As in the preceding year, the Water Resources Branch conducted studies of surface water and groundwater and of water quality. Nathan Grover, the former Chief Hydraulic Engineer, was recalled to active service with the USGS on April 20, 1942. Members of the Branch's Surface Water Division continued to collect records of the stage, quantity, and availability of surface waters at about 5,000 gaging stations and to make periodic measurements of water levels or artesian pressure in some 7,000 observation wells. Division personnel made the surface-water studies in every State and the Territory of Hawaii, for the most part in cooperation with 161 State and municipal organizations or other Federal agencies. Their work was aided by the new manual for stream-gaging procedures, begun by a Branch committee in 1930, continued from 1934 by Don M. Corbett and Charles H. Pierce, and their colleagues Marion C. Boyer, Arthur H. Frazier, and Guy C. Stevens, and published in 1943. To aid the Branch's work, Congress and the President authorized Secretary Ickes and the USGS on December 24, 1942, to acquire lands for use in establishing stream-gaging stations and to obtain easements or rights-of-way to them; lands could be acquired by condemnation, donation, or purchase from



This graph shows the concentrations of eight ions (four of which were combined in two of the six patterns) in samples of groundwater taken during 1940–44 from five wells and one spring in the Gila River Basin below the mouth of Bonita Creek. John D. Hem, Raymond T. Kiser, and their USGS colleagues, with cooperation from the Arizona State Land Commission, the Army Engineers, the Defense Plant Corporation, the Office of Indian Affairs, and the Phelps Dodge Corporation, analyzed changes in surface-water and groundwater quality and the effects of bottom-land vegetation in the nearly 12,900-square-mile area of the Gila River Basin above Coolidge Dam during January 1940–December 1944. (From Hem, 1950, fig. 6.)

appropriations, and they could be "not in excess of ten acres for any one * * * station."[107] Groundwater investigations continued in nearly every State and in Hawaii, where they included cooperative efforts with 61 State and municipal agencies. Groundwater studies included those involving most of the critical areas of heavy pumping to determine whether or not war demands caused significant shortages in water supplies. More than 9,000 water samples, many of them collected in connection with investigations of supplies for Army and Navy establishments, and for munitions plants and housing developments, were chemically analyzed in five Branch laboratories in Albuquerque, New Mexico, Austin, Texas, Raleigh, North Carolina, Safford, Arizona and Washington, D.C. Cooperative studies of the chemical character of surface waters were underway in six States. The Branch also continued other activities, including publishing the monthly *Water Resources Review*, administering responsibilities relating to permits and licenses of the Federal Power Commission (FPC), and investigating water problems along the boundary between the United States and Canada. Between June 1943 and February 1944, Nelson Sayre and George C. Taylor, Jr., investigated groundwater resources in El Salvador and Nicaragua for the Office of the Coordinator of Inter-American Affairs.[108]

The Interior Department's appropriations act, a supplemental funding bill, and transfer monies from other Federal agencies gave the USGS Conservation Branch more than $856,000 for fiscal year 1943–44, a gain of some $273,000 from fiscal 1942–43. Increased demands for new sources of oil, gas, coal, magnesium, and potassium produced a 38-percent rise in the number of mineral-classification cases during the year to almost 10,900. Members of the Water and Power Division, in addition to re-evaluating power-site reservations, made topographic surveys of 142 linear miles of river valleys and published maps of 580 miles of river valleys and 8 dam sites. To meet the heightened demands for service, the Branch established new regional field offices, each with a resident geologist in charge, at Los Angeles, California, and Great Falls, Montana, and opened suboffices in the Denver region at Casper, Wyoming, and at Salt Lake City, Utah.

Members of the Conservation Branch's Mining Division supervised operations on 636 public-land properties, 225 Indian properties, and 4 Secretarial authorizations, from which the output value totaled more than $62 million. Mining Division personnel undertook two special studies to try to resolve the problems caused by the war-induced expansion of mining operations. Under instructions from Secretary Ickes to reverse the accelerated diminution of known potash reserves in New Mexico, the USBM and the USGS contracted for test-hole drilling that proved additional high-grade reserves of national importance in and adjacent to the potash reserves President Hoover created by an Executive order in 1932. In Oklahoma, zinc production from leased Indian lands depended on working ores of successively lower grade, which was made feasible by production premiums. Joint studies there aimed to increase production by improving recovery practices and determining probable reserves of low-grade ore that might be mined by large-scale mechanized operations.

Members of the Conservation Branch's Oil and Gas Leasing Division, operating from 18 field offices and suboffices in 7 States, supervised more than 5,300 public-land properties and nearly 4,600 leaseholds on Indian lands. Division personnel also managed production from properties under lease in California's Naval Petroleum Reserve No. 2. The Division opened new suboffices at Bakersfield in California and at Artesia (between Roswell and Carlsbad) in New Mexico. Its members reported notable increases in energy-resource production from Indian lands in Oklahoma, Montana, and Wyoming. Income from supervised operations in the public domain, including Indian lands and NPR–2, amounted to nearly $3,545,000, an overall increase of $445,000 from fiscal year 1942–43, but a total that also represented a loss of $240,000 in royalties as the number of active wells in the NPRs

fell from 300 to 259. Production under approved unit agreements constituted about 59 percent of the petroleum, 69 percent of the natural gas, and 84 percent of the gasoline and butane obtained from the public lands. During the fall of 1943, however, the USGS suggestion to make unitization mandatory created considerable opposition among oil operators who preferred voluntary agreements.

During the late spring, summer, and early fall of 1943, the Federal Government made major changes in its program of mobilizing the Nation's resources. On May 27, as the effort to enlist all national resources still limped along, President Roosevelt established the Office of War Mobilization (OWM) "To develop unified programs" and "to provide for the more effective coordination of the mobilization of the Nation for war."[109] This time, Roosevelt did not add just another stratum to the bureaucratic layering. The next day, as the USGS delegation met with the Senate subcommittee on Interior's appropriations, the President appointed OES Director James Byrnes to lead the new superagency. As head of OWM, Byrnes became in fact what many called him during preceding months, "for all practical purposes * * * [another] Assistant President."[110] Byrnes' initial efforts to develop unified programs and more effective coordination included trying to resolve the long-smoldering conflict between Vice President Henry Wallace, head of the Board of Economic Warfare, and Commerce Secretary Jesse Jones over the purchase of strategic minerals, a struggle similar to the one that Donald Nelson and Brehon Somervell waged to control war production. On July 15, 1943, Roosevelt abolished the BEW and transferred its functions to a new agency, the Office of Economic Warfare (OEW)[111] established in the Office for Emergency Management. At the same time, the Export-Import Bank, the U.S. Commercial Company, the Rubber Development Corporation, and the Petroleum Reserves Corporation (PRCo), together with the functions, powers, and duties of the Reconstruction Finance Corporation and the Secretary of Commerce with respect to them, also passed to the new OEW. Roosevelt named Leo T. Crowley, Chairman of the Board of Standard Gas and Electric Company and the Alien Property Custodian since 1942, to lead the OEW. By August 1943, the Nation's minerals and metals situation improved to such an extent that the growing stocks of the resources seemed to be potential threats to raw-materials markets at the end of the war. To guard against that possibility, the War Production Board reduced stockpile objectives to a 1-year supply.

When Roosevelt established the Foreign Economic Administration as an umbrella agency on September 25, 1943, and appointed Crowley to lead it, the President expressed one of the extreme views of the United States' role in the postwar world. Vice President Wallace envisioned a worldwide New Deal that would use American resources in reconstructing the globe's devastated areas. Influential publisher Henry R. Luce, on the other hand, proclaimed the coming of the American Century, in which the world would be a vast market for U.S. businesses and be remade gradually in the American mode by their efforts. Wendell Willkie provided one of the most compelling voices for internationalism. His book, "One World," published early in 1943, sold a million copies in just 8 weeks. Willkie, who believed that whatever was secured for internationalism had to be won during the war and not in the subsequent peace,[112] urged that during the fighting the United Nations must develop mechanisms for working together after the combat ended. The alternative seemed to require ad hoc and convenient choices that could breed subsequent discord among newly freed peoples and countries, not just those of the United Nations.[113] Willkie concluded that to win the peace, three goals must be met: (1) worldwide peace must be planned for immediately; (2) worldwide economic and political freedom must be secured promptly; and (3) the United States must actively and meaningfully help to win the war and then keep a worldwide peace.[114] Roosevelt, remembering well the Senate's vote to keep the United States out of the League of Nations after World War I and the country's subsequent long interval of

isolationism, proceeded with extreme caution on postwar organization throughout most of 1943. He did allow Secretary Hull and others in the State Department to move ahead quietly on postwar planning. Founding the FEA made this and related efforts more public. Roosevelt moved the Lend-Lease Administration, Foreign Relief and Rehabilitation operations, and the OEW into the FEA. In late October, Crowley reorganized the FEA into two parts—Areas and Supplies. Areas included general, liberated, special, German-Austrian, and Pan-American bureaus. Supplies included export and import controls and the Lend-Lease Program. The FEA brought in new consultants and administrators, many from banking and business who tended to regard the new agency as a spearhead for protecting and promoting American commerce during the war and providing an aggressive export policy after it ended.

The Federal Government also considered the mobilization of scientific resources in the postwar world. Science became so important to the war effort that on July 8, 1943, a bipartisan group of 23 Senators, representing all the Nation's major geographical regions and led by Harley M. Kilgore (D–WV), who served on the Truman committee, asked James Byrnes to set up a central scientific and technical body. Kilgore and his legislative colleagues knew well Vannevar Bush's insistence that the Office of Scientific Research and Development (OSRD) was purely a temporary agency and that Congress would have to make fundamental decisions about the future of Government-supported science once the war ended. Kilgore, who arranged major hearings before a subcommittee of the Senate Committee on Military Affairs in 1942 and 1943, viewed the problem of science and government from the perspective of the war industry and, hence, science as applied science. The Senate hearings therefore stressed inventions, patents, industrial research for small business, and the imperfect utilization of technical manpower. As the OSRD did not work on materials or methods of wide use in industry, and generally did not concern itself with supplying research support to war industry, the Kilgore subcommittee aimed at recommending an organization to work in such an area. Bush opposed Kilgore's bill to establish a formal and general office of technical mobilization, to be led by a director appointed by the President and approved by the Senate.

In the fall of 1943, as the Roosevelt administration cautiously moved ahead on postwar planning, Allied offensives in the Pacific and in the Mediterranean continued as part of the proposed return to the Philippines and to Western Europe. On the Eastern Front, the Wehrmacht's offensive forces in February and March, moving east against heavy odds, recaptured Kharkov. On July 9–10, as the Germans and the Soviets struggled at Kursk in the war's largest tank battle,[115] Patton's 7th Army landed on Sicily near Gela and Licata, and moved on that area's airfields, while Montgomery's 8th Army came ashore on the Pachino Peninsula and on beaches southwest of the Naval Base Syracuse-Augusta. Patton's army, supported by the 401st Water-Supply Battalion and the 517th Water-Supply Company (both with USGS hydrologists in uniform), struck northwest and then east, as the British forces slowly moved north. Although Italy joined the Allies late in July, German planners intended to delay the Allied forces only as long as required to withdraw Axis troops across the narrow Strait of Messina to Calabria. The 15th Army Group occupied all of Sicily by August 17, but some 50,000 Germans and most of their vehicles escaped in a masterful withdrawal led by General of Panzer Troops Hans V. Hube.[116]

The MGU's terrain-intelligence reports about Sicily, especially the summary of the eastern half of the island, "won the Unit its spurs,"[117] and the Army Engineers provided the MGU with $233,000 for operations and salaries in fiscal year 1943–44. After Sicily fell, giving the Allies new air and other bases and access to additional sulfur deposits, Colonel Davidson appraised the information in the MGU's folios.

Davidson termed the intelligence about anchorages, beaches, harbors, powerplants and powerlines, railroads, rivers, roads, and weather received from the other civilian and military organizations cooperating with General Reybold's office, as "accurate and complete * * * [and] at times indispensable."[118] General Reybold personally expressed the Army Engineers' appreciation to USGS Director William Wrather for the MGU's "valuable contribution to the success of our arms," especially "the Sicilian studies * * * extremely useful both in the planning stages and in actual field operations."[119]

After gaining Sicily, the Allies moved to increase their control of the Mediterranean and continued reclaiming Soviet lands from the Germans. During the Trident Conference in Washington in May, the Allies agreed to invade the Italian mainland and to postpone for a year the cross-Channel invasion of France. On September 3, the British 8th Army crossed the Strait of Messina and invaded Calabria. The Italians agreed to an armistice on September 8, the same day that civilians on Corsica rose against the Italo-German garrison. On September 9, the U.S. 5th Army, under Lt. General Mark W. Clark, assaulted beaches in the Gulf of Salerno, south of Naples, and British forces landed at Taranto. Mussolini and diehard Italian Fascists established in the north the Salo Republic. The Germans withdrew from Sardinia, and British troops occupied the island on September 18. Sardinia, unlike mineral-deficient Corsica, held significant deposits of antimony, coal, copper, lead, lignite, salt, talc, and zinc. After holding off skillful German counterattacks, the Allies broke the stubborn cordon around Salerno in mid-September and took Naples and its heavily damaged port on October 2. The Allied armies then began slogging north up the often-muddy peninsula and across German defensive lines anchored on mountain ranges and rivers, toward Rome, aided by supporting units that included Frank Foley's Army Engineer construction battalion. In Russia, the German offensive regained lands eastward in a salient reaching the Don River, but Soviet forces again counterattacked. By the end of November, the Red Army recaptured Smolensk and Kiev, reached the Dnieper, and isolated the German troops in the Crimea.

Allied forces also advanced in the Pacific. In the Southwest Pacific, General MacArthur's American and Australian units continued to leapfrog west along New Guinea's northern coast. Coevally, Marine and Army units continued to move northwest up the Solomons; they captured Munda on New Georgia, landed on Vella Lavella, and prepared to invade Bougainville, where Admiral Yamamoto died on April 18 when USAAF fighter pilots, primed by decoded messages, ambushed his aerial party. Admiral Koga Mineichi, Yamamoto's successor, faced a new attack on the Japanese perimeter. In the Central Pacific, Admiral Nimitz's forces planned a series of assaults on Micronesian atolls in the Gilbert and Marshall Islands.

In the fall of 1943, the U.S. Government increased its consideration of the state of the postwar world. A bipartisan movement designed to commit America to participation in an international organization, formed to found and enforce global peace, began in the Senate in March but the House took action first. On September 21, by an overwhelming vote,[120] the Representatives passed a concurrent resolution, offered by J. William Fulbright (D–AR) that favored establishing an international entity with the authority and power sufficient to reach and maintain a just and lasting peace among the nations of the world, with the participation of the United States by means of its constitutional processes. The Senate Committee on Foreign Relations proposed instead a more general resolution that incited prolonged debate between the isolationists and a group of interventionists led by Senators Ball, Burton, Hatch, and Hill who favored greater U.S. involvement. On November 5, the Senate adopted a resolution by Thomas Connally similar to Fulbright's but one requiring Senate ratification of any international accord. When Roosevelt signed the agreement to establish the United Nations Relief and Rehabilitation

Administration on November 9, he echoed Willkie by noting that "As in most of the difficult and complex things in life, Nations will learn to work together only by actually working together."[121]

By that time, the United States, Great Britain, and the Soviet Union were beginning to cooperate more effectively. During the summer, many grievances and misunderstandings strained American-Soviet relations, even though the Soviets now received Allied war supplies in increasing amounts but not any data on Tube Alloys. Henry Stimson, Vannevar Bush, and lawyer Harvey H. Bundy, Stimson's principal contact with General Groves' Manhattan Project, conferred in London on July 23, 1943, with Churchill and Oxford physicist Frederick A. Lindemann, Lord Cherwell. Lindemann was the Prime Minister's principal scientific adviser rather than Tizard, who, after opposing Lindemann's policy of saturation-bombing German cities rather than concentrating air attacks on U-boat bases and other strategic targets, returned to Oxford in 1942. The attendees agreed on the details of exchanging Tube Alloys' information and personnel.

At the Quadrant Conference in Quebec, during August 14–24, attended only by American and British representatives, Churchill and Roosevelt agreed on the 19th never to use the nuclear weapon against each other, not to give information about or employ it on a third country without mutual agreement, and to share in a fair and just postwar production. The two leaders set up a Combined Policy Committee[122] composed of Stimson, Bush, Conant, Field Marshall John G. Dill, the former Chief of the Imperial General Staff and now head of the British Joint Staff Mission in Washington, Colonel John J. Llewellin, the British Ministry of Supply's representative in the Capital, and Clarence D. Howe of Canada. General Groves and Charles Leith acted as advisers to the Combined Policy Committee, while Harvey Bundy served as the Committee's American secretary for its information-exchange, progress-review, materials-allocation, plant-production, and related functions. Roosevelt also accepted Churchill's proposal to establish a Southeast Asia command, led by a British officer, and the Prime Minister agreed to the President's idea that an American should direct the invasion of France. After the Quebec meeting, Stalin bitterly complained that the campaign in Italy was not the long-promised Second Front because it involved far fewer German divisions than the Allied forces opposed. Stalin accused Roosevelt and Churchill of allowing Soviet forces to take the brunt of the fighting while keeping it out of effective decisionmaking about the global conflict and the postwar world. Unexpectedly, Stalin then endorsed the idea of a gathering of foreign ministers in Moscow and agreed to meet with Churchill and Roosevelt near the end of the year.

The Allies held their initial three-power ministers meeting during October 19–30, 1943. Secretary of State Hull, Foreign Secretary R. Anthony Eden, Foreign Minister Molotov, and some of their military advisers convened in the Soviet capital, where businessman W. Averell Harriman, formerly with the OPM, became U.S. Ambassador on October 1. Harriman's friendship with Harry Hopkins gave him direct access to Roosevelt, who made him responsible for coordinating lend-lease activities in London and then Moscow. In the Moscow Declaration, signed at the close of the conference, the three ministers adopted the American draft for a four-power pact (including China) that recognized

> **the necessity of establishing at the earliest practicable date a general international organization,[123]**

with membership open to all peace-loving sovereign states, to maintain global peace and security. The foreign ministers also established a framework for the meeting of the "Big Three" proposed in May, recognized China as a member of the Grand Alliance, and confirmed the plan to invade France in May 1944 and the decision that the Nazis must surrender unconditionally to the Grand Alliance. They also

promised to set up a European Advisory Commission to work out the basic principles for the postwar treatment of Germany and proposed an Allied commission to investigate war crimes. Stalin pledged to enter the war against Japan after the Allies defeated Germany.

As agreed during the Moscow meeting, Churchill, Roosevelt, Stalin, and their staffs met in the Eureka Conference at Tehran in Iran between November 28 and December 1, 1943. Roosevelt, Arnold, King, Leahy, and Marshall sailed to Oran, then flew to Cairo to confer with Churchill and Chiang Kai-shek in the first Sextant Conference during November 22–30. Continuing by air to Tehran, Roosevelt and Churchill chiefly discussed with Stalin the Allied invasion of Western Europe, by American, British, Canadian, and Free French forces in May 1944, supported by a flanking attack on the French Mediterranean coast and timed to coincide with a Soviet general offensive against Germany's Eastern Front. Stalin again pledged to enter the conflict with Japan when Germany was beaten, but he refused to recognize the Polish government in exile in London and presented his version of Poland's postwar frontiers. The conferees also formulated a plan for an international organization to keep the peace.

Returning from Tehran, Roosevelt and Churchill stopped at Cairo to talk again with Chiang (December 4–6). In the two meetings in Cairo, these three of the now "Big Four" leaders agreed to continue the war against Japan until its leaders surrendered unconditionally. Then they would deprive Japan of all the Pacific islands it acquired since 1914, restore to China all of its territories conquered by the Japanese, and later secure a free and independent Korea. After Roosevelt announced that he could not spare General Marshall from Washington, the President and Churchill agreed to appoint General Eisenhower as the Supreme Commander of the Allied Expeditionary Forces for the invasion of France and General Montgomery as commander of Eisenhower's land forces. Lord Louis Mountbatten, King George VI's cousin and now an acting Vice Admiral, became Supreme Allied Commander for South East Asia earlier in 1943. Churchill also met for a second time with Ismet Inönü, Mustafa Kemal's successor as president of Turkey, who again refused to join the war against the Axis. Roosevelt reported the results of these conferences to Americans by radio on December 24. The President relayed his favorable impression of Marshal Stalin and asserted that "we are going to get along very well with him and the Russian people."[124] Recalling recent combats in the Pacific and Mediterranean, Roosevelt predicted many bigger and costlier battles ahead. Americans should expect, he cautioned, "large casualty lists—dead, wounded, and missing. War entails just that. There is no easy road to victory. And the end is not yet in sight."[125]

In the fall of 1943, America's war production reached a peak and thoughts began to emerge about scaling back military output and reconverting U.S. industry to civilian production. Although the Nation's mineral situation now was well in hand, the status of its petroleum resources was becoming increasingly difficult. Although Roosevelt told Congress on September 17 that "Since the outbreak of war in Europe, we have increased our output of petroleum by 66 percent,"[126] the rise proved insufficient to meet every need. The demand for oil in the United States reached an all-time high as requirements for aviation gasoline and fuel oil for shipping and naval uses increased significantly after the year's first quarter. Transportation of these products now posed less of a problem than ensuring their supply as a result of increased tank-car movements, greater and more secure ocean-tanker traffic, and the reopening of the Mediterranean route to Persian Gulf oil that made unnecessary the longer haul around Africa. Two new domestic pipelines would further increase the flow of petroleum and its products—the Big Inch, a 24-inch-dameter pipe for crude oil, and the Little Inch, a 20-inch-diameter pipe for gasoline

and other refined products. The two pipelines, begun, respectively, in August 1942 and April 1943, would carry hundreds of thousands of barrels each day from Texas and the Southwest across, respectively, 1,254 miles and 1,475 miles to the East Coast, when completed early in 1944.[127]

The major problem in petroleum now shifted to the supply of crude oil. Production of crude in the United States was approaching the maximum rate desirable with respect to conservation. Since July 14, 1943, Ickes served as president of the Petroleum Reserves Corporation (PRCo),[128] founded on June 30 by Roosevelt, with the support of Ickes and Assistant Secretary of the Navy William C. Bullitt. The PRCo's Board of Directors included the Secretaries of State, War, Navy, and Interior and the FEA's Director. Ickes again claimed that America, drawing heavily on its own reserves, was running out of oil. Known reserves, he predicted, would last only 12 to 13 years at the prewar rate of consumption; the Nation could not service another global conflict or prepare properly for peace, and soon it would be a net importer of petroleum. To compensate in part, Ickes called for oil production from coal and oil shale, but commercial amounts from these sources required far more research and development than that yet done by the USBM pilot program. Senator George echoed the Secretary's warning by agreeing that the United States would be a future supplicant for petroleum. William Heroy, Director of Reserves in Ickes' Petroleum Administration for War since July 7, 1942, predicted that without new U.S. fields, the domestic supply would eventually be exhausted. "Industry," Heroy asserted, "is challenged as never before to find, develop, and produce more oil."[129] Clearly, the Allies needed additional sources of supply to meet their war needs. When U.S. domestic-exploration programs could not supply these requirements quickly enough, imports increased sharply, and they stimulated American interest in foreign sources. Senator Henry C. Lodge, Jr. (R–MA), asked the administration to involve itself directly in concessions abroad.

The House Committee on Interstate and Foreign Commerce's investigation of petroleum resources noted in July 1943 that "There are great supplies of oil in the Persian Gulf area. More substantial supplies should now come from that source."[130] In the view of Clarence Lea's committee,

> **the conservation of our own resources, as well as a more assured supply for military and civilian purposes, require that every practicable effort be made to increase these foreign supplies for war purposes. Such increase would decrease the demands upon our oil reserves, shorten our shiplines, reduce the war transportation hazards, increase the amount available for civilian use, and prolong the available supply of oil for America.[131]**

Historian Daniel Yergin's "The Prize" described and analyzed the major roles that Gulf, Standard Oil Company of California (Socal), and Texaco, three of the "Seven Sisters" companies, played in gaining American concessions for oil exploration and development in the Middle East beginning in the late 1920s. Socal found commercial quantities of oil at Awali in Bahrain in 1932, the year Abd al-Aziz [II] Ibn Abd al-Rahman al Saud, known in the West as Abdul Aziz Ibn Saud, or just Ibn Saud, but as Abd al-Aziz to his people, established the modern Kingdom of Saudi Arabia. Ibn Saud claimed kingship in 1926 and received prompt recognition as such from the Soviet Union and Britain, although America delayed its acceptance until 1931. The following year, the King united most of the Arabian Peninsula under his caliph-like dual role as its secular ruler and also hereditary spiritual leader of the ultraconservative Wahhabist-Sunnis.

King Ibn Saud hoped that his domain contained oil and other valuable resources, but he especially wanted artesian wells and other new supplies of water. In 1923–24, he granted oil concessions in the Hasā (Ahsā) region, just west of

Bahrain, and in the Neutral Zone that Saudi Arabia shared with Kuwait, to Frank Holmes' Eastern and General Syndicate after the Anglo-Persian Oil Company found Saudi Arabia's prospects unpromising. The concession yielded only the rental fee before it passed to Holmes and Gulf and then to Socal, whose Canadian-cooperative Bahrain Petroleum began drilling at Awali in October 1931 and stuck commercial quantities of oil during the following May. Between February and May 1933, Sheik Abdullah Suleiman al-Hamdan, Ibn Saud's Minister of Finance and National Economy, Socal representatives, Britain's Harry St.J.B. ("Jack") Philby, and Karl S. Twitchell (a U.S. mining engineer who tried but failed to find artesian wells in the Kingdom) negotiated a revised Hasā concession. Ibn Saud regranted for 60 years the 360,000-square-mile concession to the California Arabian Standard Oil Company (Casoc), Socal's operating unit. Casoc offered a far greater sum against royalties than did Anglo-Persian and Iraq Petroleum—$175,000 as an up-front loan and first-year royalty, another $100,000 as a loan in 18 months, and a third $500,000 loan for a commercial discovery.[132] Casoc also promised to educate Saudis to replace American workers as quickly as possible without losing economy or efficiency. In December 1934, Gulf and Anglo-Persian signed a 75-year concession with Sheikh Ahmad al-Sabah, the Emir of Kuwait and Ibn Saud's ally. The two companies brought in a high-sulfur discovery well at Burgan in southeastern Kuwait in February 1938.

Meanwhile, Casoc's geologists explored the Hasā concession and quickly focused on the "two backs" anticline at Jabal Dhahran (Zahrān), also known as the Dammam Dome, inland from the fishing village of Dammām, and about 25 miles west of Bahrain's Awali oil field. Seismological surveys and aerial photography aided their ground studies. Drilling began during the summer of 1934, but six expensive wells drilled into the eastern extension of the "zone" at Awali produced only shows of oil or water, and dry holes. Casoc's drillers extended Dammam No. 7 to below 4,700 feet and, on March 16, 1938, they struck commercial quantities of oil in what became known as the "Arab zone."[133] Socal then exercised a secret clause in the 1933 agreement to expand the concession by 80,000 square miles. In April 1939, King Ibn Saud visited Casoc's pipeline terminus at Ras Tantra (Tannūrah) on the Persian Gulf as the initial tanker began loading crude oil. He and President Roosevelt exchanged letters, but the wily monarch also made arms deals with the Germans and Italians. In August 1939, the State Department made the U.S. minister to Egypt additionally responsible for representing America in Saudi Arabia. Full diplomatic recognition of the Kingdom followed in February 1940. Eight months later, four Italian aircraft flew from Rhodes to Massawa on Eritrea's Red Sea coast, bombing en route but not damaging targets in Bahrain and the stabilization plant at Dhahran, Casoc's operations center, about 8 miles south of Dammām. Casoc made additional discoveries south and north of Dhahran, and production rose to 20,000 barrels a day during 1940,[134] but the increasing Italo-German threat to the region led to reducing the staff for field operations, cutting the number of employees at Dhahran and the small refinery at Ras Tantra (like the pipeline, built by Bechtel International), and plugging all the wells in Kuwait.

Ibn Saud awaited the military outcome in Africa and the Near East. The King, still wary of the British, requested additional aid from the United States. In February 1942, Roosevelt, knowing British concerns, rejected Casoc's request of the previous April to advance Ibn Saud some $6 million per year against future oil royalties. During 1943, the administration focused on U.S. interests in the region both during and after the war. In January, Assistant Secretary of State Dean Acheson asked Lend-Lease Administrator Edward Stettinius to make Saudi Arabia eligible for aid. In mid-February, the presidents of Socal, Casoc, and Texaco traveled to Washington to urge State Department officials to send their money or Federal dollars to Ibn Saud and to block the British. Roosevelt lunched with Ickes on February

Geologist Everette Lee DeGolyer (1886–1956), like Wrather, worked for the USGS in 1907. He then joined an oil company that became the British-Mexican El Aguila and located prolific oil fields along the Golden Lane structural trend. After 1916, DeGolyer continued to study salt-dome fields and geophysical applications while organizing three firms—Amerada Petroleum, the Geophysical Research Corporation, and DeGolyer and MacNaughton. During World War II, DeGolyer served as Director of Conservation and then Assistant Deputy Administrator of Harold Ickes' Petroleum Administration for War. In 1943, DeGolyer joined other colleagues in recommending William Wrather, his friend and fellow bibliophile, to Interior Secretary Ickes to replace Mendenhall as USGS Director and also serve on DeGolyer's Middle East Oil Mission. In postwar years, DeGolyer continued to advise organizations in academia, government, industry, and science. (Photograph from Pratt, 1958, pl. 5; also published in Tinkle, 1970, frontispiece.)

16. Two days later, the President found Saudi Arabia's defense vital to the United States and authorized lend-lease aid to the Kingdom. In June the JCS's Army-Navy Petroleum Board, originally established by General Somervell and the Vice CNO in July 1942 to coordinate petroleum operations for all U.S. armed forces, predicted serious shortfalls in U.S. petroleum production for 1944. Shortly after the Board's projection, Harold Ickes, Frank Knox, Henry Stimson, and James Byrnes, while lunching at the White House later that month, agreed that the administration must become more actively involved in Saudi Arabia. In August 1943, Ickes offered the presidents of Socal and Texaco, now equal partners in the renamed Caltex in Saudi Arabia, a Federal takeover of all or part of the concession in the manner of the now Anglo-Iranian Oil Company. Ickes suggested Caltex should be restyled American-Arabian, offered to buy one-third of the company for $40 million, which would fund a new and larger refinery at Ras Tantra, and indicated that the Federal Government would settle for 51 percent of the operation in peacetime but wanted 100 percent during war.[135] The companies' presidents refused; they already opposed Ickes' policies as head of the PRCo and any restrictive Federal control after the war.

As part of the Roosevelt administration's new diplomatic offensive, the President invited Ibn Saud to visit the United States. Neither the King nor Crown Prince Saud could make the trip, and so the monarch sent his second son, Prince Faisal, and Faisal's half-brother, Prince Khalid. They arrived in Washington by air on September 30, 1943. Secretary Hull remained indisposed and Under Secretary Sumner Welles' resignation on August 16, requested for security reasons by Roosevelt, had just become effective. Adolf A. Berle, Deputy Under Secretary and Acting Secretary of State, who directed the Department's global-intelligence operations, greeted the two Saudi princes at National Airport. Faisal, quartered at Blair House during October and November, talked with Ickes and Stettinius, now Under Secretary of State. Berle and Stettinius assured Faisal on November 1 that the United States would not support any unfriendly actions against Saudi Arabia by the King's Hashemite enemies in Iraq and in Transjordan, or through British influence there, or in the Arabian Peninsula, Palestine, Iran, or Syria. The United States would foster a "Good Neighbor" policy for the Middle East and enforce the Atlantic Charter's first and second articles that prohibited territorial aggrandizement or any changes not approved by the countries concerned.

Ickes, already Petroleum Administrator for War and president of the Petroleum Reserves Corporation, also began serving, with the Secretaries of State, War, and the Navy, on the Foreign Economic Administration's Board of Directors on July 14, 1943. The political, military, and economic concern for U.S. interests in Bahrain, Kuwait, and especially Saudi Arabia, heightened by Prince Faisal's visit, led Ickes to decide to send a U.S. technical oil mission, sponsored by the PRCo, to the Persian Gulf region to appraise independently its existing and potential resources that could be useful to the Allies during the war and to the United States after the conflict. Ickes selected Everette DeGolyer, his trusted troubleshooter, to lead the mission to the Middle East. DeGolyer, as the PAW's Assistant Deputy Administrator from June 8, 1942, to September 20, 1943, also helped Ickes promote both the Big Inch and Little Inch pipelines, for which the DeGolyer and MacNaughton firm provided the low bids. William Heroy deputized for DeGolyer, who reluctantly accepted the new assignment. DeGolyer dissuaded Ickes from sending on the mission Abe Fortas, Interior's Under Secretary since 1942.

Three men accompanied DeGolyer to the Middle East. They were DeGolyer's friend USGS Director Wrather, on detail to the PRCo, which paid his salary and his travel and other expenses; Army Colonel Jacque C. ("John") Morrell, a PAW petroleum engineer and, since January 19, 1943, one of the Special Assistants to Deputy Administrator Ralph Davies; and C. Stribling Snodgrass, Director of the PAW's Foreign Division during 1942–43 and, after October 20, 1943, Director of

the PAW's Foreign Refining Division. DeGolyer's party left the United States on November 12. U.S. officials going to the Allied conferences in Cairo and Tehran flew from Miami over the Caribbean to Port-of-Spain in Trinidad, from there southeastward to Natal in Brazil, then crossed the Atlantic to Dakar, and continued over Africa to Cairo. Security arrangements twice delayed DeGolyer's mission en route. *The Oil and Gas Journal* for November 18 reported that Ickes planned to ensure postwar peace by gaining, through "some sort of international agreement,"[136] Allied control of the world's oil resources to prevent potential aggressor nations from obtaining reserves sufficient to support military conflicts. The *Journal* apparently suspected a connection between Ickes' plan and DeGolyer's mission. Truman's committee, then holding hearings on the Army's Canol Project in northwestern Canada, also was expected to look into the global oil situation.

To serve as Acting Director of the USGS during Wrather's absence from the Capital, Thomas Nolan, then in Denver interviewing tungsten-commodity geologists, came east on a day's notice. Wrather's letter of November 3, sent to Boulder, arrived in Denver on the 11th and Nolan reached Washington 4 days later. Nolan, Foster Hewett's field-operations supervisor since 1938, was largely responsible for the organization and administration of the revived strategic-minerals program. Hewett, who disliked administrative work, generated ideas and continued to deal with the often thorny problems involved in working with the USBM and the other cooperating agencies. He also gave Nolan specific responsibility for the program's tungsten project in 1939, prelicensing reports on mines for the War Production Board (where Nolan renewed his contacts with Alan Bateman and met Wrather), and coordination with the British Geological Survey's equivalent minerals program. Wrather discussed Nolan's appointment with Interior's First Assistant Secretary Michael Straus, Julian Sears, and Foster Hewett, who all supported the selection, but not with Nolan. Wrather decided that Nolan's "intimate acquaintance with the Bureau situation" and new "position of authority" would enable him "to take any necessary steps to safeguard Survey interests." Sears last led the USGS during the directorial interregnum earlier in 1943 and did not wish to be considered for a repeat appointment because he wanted to continue as the agency's Administrative Geologist. Wrather promised Nolan that Sears "will be an invaluable adviser on many matters with which you may be unfamiliar." Sears also assured Wrather that he would give Nolan "every assistance."[137]

Geologist Thomas Brennan Nolan (1901–92) joined Gerald Loughlin's Geology of Metalliferous Deposits Section in 1924 and spent most of the next two decades assessing geology and ores in the Western United States. Nolan left his roles as tungsten-commodity geologist, straw boss for Foster Hewett's field program, and representative to related government cooperative programs to serve as Acting Director during November 1943–February 1944, while William Wrather accompanied Everette DeGolyer to the Middle East. In December 1944, Nolan filled the newly established post of Assistant Director, where he functioned as chief executive officer while Wrather operated as chairman of the board. Nolan succeeded Wrather as Director in January 1956 and served until September 1965. Nolan continued to encourage innovative basic and applied research throughout the agency, setting an example by continuing his own studies and mapping of the geology and ore deposits at Eureka, Nevada, and elsewhere in the Basin and Range Province. (Photograph from the USGS Denver Library Photographic Collection, Portraits, as port0287, https://www.sciencebase.gov/catalog/item/51dda267e4b0f72b4471df4f.)