UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

ANNOTATED BIBLIOGRAPHY OF SALT DEPOSITS:

A SUPPLEMENT TO

U. S. GEOLOGICAL SURVEY BULLETIN 1019-J*

Compiled by

Walter B. Lang, Charles B. Read, George W. Moore,

and Margaret Cooper

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Trace Elements Investigations Report 712

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ANNOTATED BIBLIOGRAPHY OF SALT DEPOSITS: A SUPPLEMENT TO U. S. GEOLOGICAL SURVEY BULLETIN 1019-J

Compiled by

Walter B. Lang, Charles B. Read, George W. Moore, and Margaret Cooper

ABSTRACT

This bibliography supplements the information on salt published in U. S. Geological Survey Bulletin 1019-J, "Annotated Bibliography and Index Map of Salt Deposits in the United States," by Walter B. Lang, 1957. The supplement contains additional information on the salt deposits of the United States and of foreign countries, as well as data on the composition, chemistry, geologic occurrences, geophysical exploration, distribution, technology, and production of salt. Additional supplements will be issued from time to time to keep the information on these subjects current.

INTRODUCTION

This bibliography is a supplement to, and should be used in connection with, U. S. Geological Survey Bulletin 1019-J, "Annotated Bibliography and Index Map of Salt Deposits in the United States," by Walter B. Lang, 1957. Bulletin 1019-J is in an envelope at the back of this report.* None of the references in the present bibliography appears in this bulletin, which "contains references, to June 1956, on distribution of salt deposits, geologic occurrences, geophysical exploration, technology, experimental research, and historical accounts." This supplement includes additional information on the salt deposits of the United States and of foreign countries, as well as data on the composition, distribution, geology,

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*Not included with Geological Survey copies chemistry, mineralogy, and history of salt deposits, but should not be construed as a final and complete compilation of all available references on these subjects not covered in the bulletin. To keep the bibliography more nearly current, additional supplements will be issued from time to time as sufficient material is assembled.

Foreign papers included in this bibliography are cited by both their original and translated titles, with a notation of the language in which the original text is written. Where abstracts in English or another foreign language accompany the original text, this fact has also been indicated.

The bibliography listings have been arranged alphabetically by the surname of the first author. A combination geographic and subject index follows the bibliography. The headings in it are those used in the index to Bulletin 1019-J with a few additions. Under the heading, "Composition of salt," have been included references giving complete or partial analyses of the chemical composition of the salts involved.

In the annotations for the bibliography, abstracts taken directly from the "Annotated Bibliography of Economic Geology," "Chemical Abstracts," or the Geological Society of America's "Bibliography and Index of Geology Exclusive of North America," are followed by a listing of the volume, year, and column or page number and, where given, the name or initials of the abstractor. Author abstracts have also been used where available and are so indicated. The remaining abstracts were prepared by the various compilers.

This work is part of a program that the U. S. Geological Survey is conducting in connection with its Investigations of Geologic Processes project on behalf of the Division of Research, U. S. Atomic Energy Commission.

BIBLIOGRAPHY

Abdalian, S., 1951, L'île d'Ormuz dans le Golfe Persique (Island of Ormuz in the Persian Gulf): Nature (Paris), v. 79, no. 3190, p. 33-38. (French text)

Ormuz island in the Persian gulf represents an isolated fragment of the intensely folded Tertiary formations of southern Iran. Extensive rock salt masses, which ascended from depth, and thick lenses of hematite, whose origin is considered to have been associated with magmatic activity in the initial stages of Oligocene orogenic activity, are exploited on the island. (G.S.A. Bibl., v. 20, 1955, 1)

Ahlfeld, Federico, 1948, La boratera de Coyaguaima, provincia de Jujuy (Borates of Coyaguaima, Province of Jujuy): Asoc. Geol. Argentina, Rev., tomo 3, no. 4, p. 271-278. (Spanish text; English abstract)

Describes a thermal deposit of boronatrocalcite at Coyaguaima hill, Jujuy province, Argentina. The deposit, of economic value, is of Recent age. The possibility is discussed that the big secondary borate deposits of salt pans originate from the leaching of small thermal deposits. (G.S.A. Bibl., v. 13, 1948, 3)

Alberta, Dept. of Economic Affairs, 1948, Alberta's salt industry: Western Miner, v. 21, no. 8, p. 156-157.

Relates to the initial production of salt by the Alberta Salt Co., Elk Point, Alberta, where a new plant has been erected to evaporate brines pumped from solution of rock salt in beds from 2,000 to 4,000 feet below the surface. W.B.L.

Aleksandrov, G. P., and Levchenko, T. F., 1953, K voprosu o sodershchanii broma i ioda v Kamennoi soli Zakapratskogo mestoroshchdeniya (On the question of the bromine and iodine in rock salt from the Transcarpathian deposits): Gigiena i Sanitariya (Moscow), no. 1, p. 43. (Russian text)

It was found that Br is distributed quite uniformly throughout the rock-salt deposits at 0.0022-0.0046% concentration, while I is concentrated largely in the deeper strata with concentration of 0.00002-0.00004%. G. M. Kosalapoff (Chem. Abst. 47, 1953, 9868)

Allberry, E. C. See Haslam, J., 1950

Allchin, J. P. See Friend, J. N., 1940

Amoros, Jesus Mir See Mir Amoros, Jesus.

Anferova, L. V. See Epshtein, V. V., 1950.

Angelelli, Victorio, and Valvano, J., 1946, La fosgenita primaria del Salar del Plomo (The primary phosgenite of Salar del Plomo): Soc. Geol. Argentina, Rev., tomo 1, no. 4, p. 257-269. (Spanish text; English abstract)

A large phosgenite deposit is described in a small salty basin called Salar del Plomo, in Antofagasta de la Sierra, Catamarca, Argentina. Mineral and chemical analyses, and theories of origin are given. (G.S.A. Bibl., v. 12, 1947, 7)

Ans, J. d'. See D'Ans, J.

Arend, K. V., 1931, Sobre la existencia de potasa en la provincia de Tarapaca y sobre la posibilidad de la fabricacion de nitrato de potasio en gran escala (On the existence of potash in the province of Tarapaca and the possibility of using it to manufacture nitrate of potash on a large scale): Bol. Minero (Santiago de Chile), v. 43, no. 390, p. 784-790. (Spanish text)

The potassium occurs in the caliche and in the salt lake deposits. Most of the areas carrying sodium nitrate carry also potassium, in some cases as high as 7-10 percent, calculated as potassium nitrate. Polyhalite is the most important potash salt. Some fields contain up to 3-3.5 percent. There is little information regarding the quantity of potassium in the salt lake deposits. Some beds contain only traces and others as high as 14 percent calculated as chloride. Polyhalite is the most important potassium salt also in the salt beds. The potassium-bearing caliche would be the main source for the recovery of potassium, and the extraction of it in the form of potassium nitrate in combination with the recovery of sodium nitrate should be profitable. L.M.P. (Ann. Bibl. Econ. Geol., v. 5, 1932, 81)

Assarsson, Gunnar, 1949, On the winning of salt from the brines in southern Sweden: Sveriges geol. undersökning, Årsbok 42 for 1948, no. 10, (s. C, Avh. och upps., no. 501), 15 pp. (English text)

Discusses the solid solution phases of ternary and quaternary systems containing KCl, NaCl, $CaCl_2$ and H_2O in the light of their significance in the exploitation of brines, with special references to the brines of Skane /Scania/, Sweden. (G.S.A. Bibl., v. 17, 1952, 16)

Baar, A., 1954, Untersuchungen des Bromgehalts im Zechsteinsalz (Investigation of the bromine content in Zechstein salt): Bergbautechnik 4 Jahrg., Heft 5, p. 284-288. (German text)

The stratigraphy of salt deposits originating from evaporated sea water can be ascertained by Br determinations. During evaporation the Br accumulates in the mother liquor so that the deposited chlorides show an increasing Br content the later they crystallized out. Therefore the content of Br in NaCl can be used like a key fossil. After the estimation of the total Cl, the NaCl in the sample is computed. If KCl and $MgCl_2$ are also present, a K_2O and Mg determination must be made and from these data the NaCl calculated and finally the proportion of Br:NaCl ascertained. The applicability of the method is demonstrated by several tests in potash mines in Germany. E. M. G. (Chem. Abst. 48, 1954, 11263)

Baier, Ernst. See Borchert, Hermann, 1953.

Bain, G. W., 1956, Concentration of brines and deposition of salts from sea water under frigid conditions: Am. Jour. Sci., v. 254, p. 758-760. (Discussion of a paper by T.G. Thompson and K.H. Nelson, same journal, p. 227-238.)

This discussion cites examples from nature to illustrate theories proposed in the original paper. Certain United States and worldwide deposits are described briefly.

Bancroft, M. F., 1938, Salt deposits at Malagash, Nova Scotia: Nova Scotia Dept. Public Works and Mines, Ann. Rept. for 1937, pt. 2, p. 5-11.

Briefly gives structural attitude of McKay and Lucas salt beds of Windsor series of the Mississippian which are folded near the surface at Malagash. Outlines geology and lithology of associated rocks and provides maps of mine workings and profile sections. Oil prospect wells and numerous salt springs indicate a wide extent of salt deposits. W. B. L.

Bandy, M. C., 1938, Mineralogy of three sulphate deposits of northern Chile: Am. Mineralogist, v. 23, p. 669-760.

A comprehensive study of the mineralogy of Chuquicamata, Quetena, and Alcaparrosa---three sulphate deposits near Calama, northern Chile. Much space is devoted to the paragenesis, descriptive mineralogy, and geochemistry of the unique sulphate and chloride minerals found here. 76 species were identified and studied; 18 are found only in northern Chile; 12 only from these three deposits. Numerous data on paragenetic sequences are given. W. P. (Ann. Bibl. Econ. Geol., v. 11, 1938, 234)

Barbour, E. H., 1916, A preliminary report on the alkali resources of Nebraska: Nebraska Geol. Survey Pub., v. 4, pt. 28, p. 405-438.

Chiefly a general account of potash resources and comparison with Nebraska alkaline lakes. Describes operations of several companies in detail. Consistently refers to Jesse Lake as "Jess Lake." Paper written in 1914 and revised in 1916. States that abstract was published in Lincoln Daily Star, Saturday, November 22, 1914.

Bergman, A. G., Valyashko, M. G., and Feigel'son, I. V., 1953, Solyanie Ozera severo-zapadnogo priaral'ya, plato Ustyurt i nizov'ev reki Amu-Dar'i (The saline lakes of the northwestern Aral Sea territory, the Plateau of Ustyurt, and the low parts of the Am-Dar'ya basin): Akad. Nauk S.S.S.R., Lab. Ozerovedeniya, Trudy, v. 2, p. 17-67. (Russian text)

Detailed description of each of the 30 lakes investigated is given, including drawings of the geologic formations and phase diagrams of the substances present, as well as the temperature and density measurements, and chemical analyses of their water (ions HCO_3^-, SO_4^{--}, Cl^-, Br^-, $B_4O_7^{--}$, Ca^{++}, Mg^{++}, K^+; salts, calcium bicarbonate, calcium sulphate, sodium sulphate, magnesium sulphate, magnesium chloride, sodium chloride, potassium chloride, sodium bromide, sodium borate) and coefficients of metamorphisation (sic), K'_{11} equals $Na_2SO_4/MgSO_4$ and K_{MK} equals $MgSO_4/MgCl_2$. Coefficients of K content, K_k equals (wt. % K/wt. % total salts) x 10^3, varying from 1.30 to 16.3, coefficients of Br content K_{Br} equals wt. % Br/wt. % total salts varying from 0.0 to 20.9, and coefficients of B content K_B equals (wt. % B_4O_7/ wt. % total salts) x 10^3 varying from 0.07 to 5.98 are also given for all the lakes, as well as the quantity NaCl/ total salts, which varies from 0.24 to 0.90. The lakes appear to be suitable for the development of salt industry. R. D. (Chem. Abst., 49, 1955, 13559)

Bertrand, Gabriel, 1938, Récherches sur la présence et la répartition du bore dans les gisements de sels potassiques d'Alsace (Studies on the presence and distribution of boron in the deposits of the potassium salts of Alsace.): Soc. chim. France Bull., ser. 5, v. 5, p. 69-73. (French text)

Determination of the B content of sylvite from 2 mines in Alsace showed 1 to 20 mg. per kg. of mineral. (Chem. Abst., 32, 1938, 3305)

Berttlingek, H. See Geilmann, W., 1942.

Biltz, Wilhelm, and Marcus, E., 1909, Über das vorkommen von Kupfer in dem Stassfurter Kalisalzlager (On the occurrence of copper in the Stassfurt potash salt deposits): Zeitschr. anorg. Chemie, v. 64, p. 236-244. (German text)

Indirect evidence furnished by the analyses of sea-plants..., of coral, seaweed and marine sediment... indicate the presence of Cu in seawater. Dieulafait... concluded that 10-12 mg. of Cu are present in 1,000 liters of seawater. The authors found traces of Cu in all portions of the Stassfurt salt deposits. In 200 g. samples there were found in the older rock salt and in the carnallite about 0.1 mg.; in the anhydrite, from 0.15 mg. in the upper layer to 0.90 mg. in the next to the lowest; in the clayey parts 0.34-1.32 mg., without reference to the order of the deposit. The Cu was determined in the form of ferrocyanide, by means of a Krüss colorimeter. NaCl in excess of 5% prevented the completed precipitation of the Cu as CuS; carnallite did not. The samples of salt and carnallite were dissolved in water and the salt content reduced by means of HCl to 5% or less whenever reduction was necessary. The clayey samples and those containing anhydrite were extracted with HCl and finally with aqua regia or with the latter alone, the aqua regia being necessary to secure complete extraction. The Cu was precipitated with H_2S, the precipitate dissolved in HNO_3, the solution concentrated to a few drops, diluted and then these processes repeated to be followed by the colorimetric estimation. For the latter a freshly made solution of $K_4Fe(CN)_6$ was each time used, otherwise the resulting yellow color interfered. From the salt content of seawater and the Cu content of the Stassfurt deposits, it was calculated that 1,000 liters of seawater contain about 17 mg. of Cu. Samples from other deposits were also found to contain Cu. The concentration of the

Biltz and Marcus--Continued.

Cu in the clayey deposits is due to adsorption, as shown by the results of shaking "silt clay" as well as fireclay with a solution of $CuSO_4$. D. M. Lichty (Chem. Abst. 4, 1910, 871)

Binyon, E. O., 1952, North Dakota sodium sulfate deposits: U. S. Bur. Mines Rept. Inv. 4880, 41 pp. (processed), illustrated (including sketch maps).

Reports results of an investigation of the reserves and grade of sodium sulfate deposits of North Dakota. The deposits, in the form of brine, intermittent crystals, and permanent beds, occur in shallow closed depressions in glacial till. An estimated 12,142,000 tons of Glauber salt are present, mainly in the northwest part of the state. (Ann. Bibl. Econ. Geol., v. 25 for 1952, 1953, 77)

Birckenbach, L. See Goubeau, J., 1938

Borchert, Hermann, and Baier, Ernst, 1953, Zur Metamorphose ozeaner Gipsablagerungen (On the metamorphosis of marine gypsum deposits): Neues Jahrb. Miner., Abh., Band 86, Heft 1, p. 103-152. (German text)

Detailed studies of marine salt deposits, especially of the Zechstein (Permian) series in Germany, lead to the conclusion that extensive beds of anhydrite were originally beds of gypsum.
A. N. W. (G.S.A. Bibl., v. 19, 1954, 50)

Bostock, H. S., Mulligan, R., and Douglas, R. J. W., 1957, The Cordilleran region [Canada]: Canada Geol. Survey, Econ. Geology ser., no. 1, 4th ed., p. 283-392. See p. 376.

Records the occurrence of sodium and magnesium salts in small undrained lakes in the area around Clinton, Chilcotin, Ashcroft, Kamloops, and Okanagan in the moderately arid interior of British Columbia. Last Chance Lake, 16 miles north of Clinton, contains a permanent deposit of crystalline salts interbedded with mud. The crystal masses range from 4 to 70 feet in diameter and are from 1 to 10 feet thick.

Bourcart, Jacques, and Ricour, Jean, 1954, Essai sur les conditions de sedimentation des niveaux salifères du Trias (Study on the conditions of sedimentation of the Triassic salt deposits): 19th Int. Geol. Cong. Comptes rendus, sec. 13, v. 13, p. 35-47. (French text)

Offers evidence against the theory that the European Triassic anhydrite, gypsum, and salt deposits were formed by evaporation of salt marshes under desert conditions, and proposes the hypothesis that the beds were formed as a result of the consolidation of thick mud deposits saturated with saline water. The salts which crystallized upon drying and burial of the mud impregnated the sediments and were concentrated in layers or pockets. (G.S.A. Bibl., v. 20, 1955, p. 61)

Boury, Maurice, 1938, Le plomb dans le milieu marin (Lead in marine medium): France, Office des Pêches Maritimes, Rev. trav. 11, fasc. 2, p. 157-165. (French text)

Samples of seawater obtained at (a) Biarritz, (b) Quiberon, and (c) Lorient, on analysis, showed (a) 3.5 mg., (b) 4.0 mg., and (c) 8 mg. of Pb per cu.m. of H_2O. Two samples of raw sea salt from Noirmoutier contained 0.8 and 1.3 mg. of Pb per kg. of salt.... Similar work by others and the analytical methods used, are reviewed. Sixteen references. T.E.R. Singer (Chem. Abst. 35, 1938, 11)

Bownocker, J. A., 1905, The salt deposits of northeastern Ohio: Am. Geologist, v. 35, p. 370-376.

Discussion of geology and occurrence of salt deposits in Ohio.

Briggs, L. I., Jr., and Lucas, P. T., 1954, Mechanism of Salina Salt deposition in the Michigan Basin (abs.): Geol. Soc. America Bull., v. 65, no. 12, pt. 2, p. 1233.

A comparison of the texture and mineralogy of a 5-foot core of the Silurian Salina salt from west-central Michigan with Usiglio's data on the chemistry of seawater evaporation indicates that the salt was deposited in annual cyclic layers. Each layer of the salt is characterized by halite, averaging 20 mm thick, underlain by a thin lamina of anhydrite averaging 0.5 mm thick. In the basal part of the layer, anhydrite is intermixed with minor amounts of dolomite and traces of quartz, hematite, and magnesite; whereas the upper part is almost pure halite with traces of anhydrite. The halite is composed of hopper-shaped crystals with cubic overgrowths of clear halite. Inasmuch as the hoppers are identical with those grown in salt pans by evaporation of seawater, the textures and mineralogy in the salt core are probably unchanged since their original deposition. Thus it is reasonably certain that they reflect the environment of deposition during a part of Salina time.

The deposition of separate anhydrite and halite laminae probably resulted from periodic influxes of seawater. If there were no new influx of brine until deposition of the subsequent anhydrite-halite layer, approximately 115 cm of influx water must have evaporated to form both anhydrite and halite layers. Since 115 cm (45 inches) is a reasonable annual evaporation rate for arid or semiarid regions, the composite anhydrite-halite layers probably represent precipitation from annual influxes of normal seawater evaporated under static conditions without continuous reflux. (Authors' abstract)

Bruggen, Juan, 1928, La geologia de los yacimientos del salitre de Chile y las teorias que tratan de explicar su origen (The geology of the nitrate deposits of Chile and the theories to explain their origin): Bol. Minero (Santiago de Chile), v. 40, no. 351, p. 394-406. (Spanish text)

A detailed summary of the geology, climate, form of the deposits, theories of origin. Concludes that nitrifying bacteria have fixed the nitrogen of the air at a time when the region was less desert than now. J.L.G. (Ann. Bibl. Econ. Geol., v. 1, 1928, 131)

________, and others, 1938, La industria del salitre de Chile (The nitrate industry of Chile): Bol. Minero (Santiago de Chile), v. 50, no. 460, p. 693-766. (Spanish text)

This section of a special issue of the journal on nitrates contains several articles by different authors, in which the character and uses of nitrates and related substances, the history of the Chilean industry, and the laws governing it are summarized. In a paper entitled "El salitre," on pages 737-754, Juan Bruggen outlines the geology of the areas containing nitrate deposits and reviews theories of genesis proposed by various writers.

Burnett, J. K. See Joplin, G. A., 1954.

Cameron, E. Lee, 1949, A review of industrial mineral developments in Manitoba: Canadian Inst. Min. Metallurgy Trans., v. 52, p. 9-14; Canadian Min. Met. Bull., v. 42, no. 441, p. 11-16. See p. 14.

Briefly reviews the early, recent, and present histories of salt occurrences and production in Manitoba, with a prophetic paragraph on future developments. At present, between 25,000 and 27,000 tons of salt are produced per year from two wells at Neepawa. W. B. L.

Carl, G. C., 1940, Some ecological conditions in a brackish lagoon: Ecology, v. 21, pp. 65-75.

Reports results of studies made on the biological conditions of the water of Lost Lagoon, a brackish lagoon, in Stanley Park, Vancouver, British Columbia, during an attempt to transform it into a freshwater lake for trout fishing.

Carter, E. K. See Joplin, G. A., 1954.

Catalano, L. R., 1930, Boratera de Coyahuaima (Borax deposits of Coyahuaima): Argentina, Dir. gen. minas, Pub.89, 57 pp. (Spanish text)

The borate deposits are east of the volcano Coyahuaima, about 25 kms. from the town of Rosario de Susquis. Ulexite is the principal borate mineral. The borate deposit said to have been formed by replacement of beds of travertine by borates introduced by thermal waters. The amount of borates estimated at more than 10,000 tons. The author concludes that the location of the deposit and the quantity and quality of the borate minerals warrant exploitation, which would be of great economic and social benefit to the surrounding region. L.B. (Ann. Bibl. Econ. Geol., v. 4, 1931, 72)

Cavaye Hazen, E., and Hoyos Ruiz, A., 1953, Contenido de yodo en muestras españolas de sal (Iodine content of Spanish samples of salt): Anales de Bromatologia (Madrid), v. 5, p. 277-286. (Spanish text; English abstract)

Samples of salt from different parts of Spain were analyzed for iodine by the methods of Kendall (C. A. 8, 3665) and Gronover (C. A. 25, 5870). Both methods are satisfactory, although the Kendall method appeared to be the more accurate of the two. Salt from Cadiz contains 62.59 γ of I/100 g., from Torrevieja 63.07 γ/100 g., and from Calczon 57.68 γ/100 g. I. Eisdorfer (Chem. Abst. 48, 1954, 5448)

Chassevent, Louis, 1932, Sur l'anhydrite et sa formation (Anhydrite and its formation): Acad. Sci. Paris Comptes rendus, v. 194, p. 786-788. (French text)

$CaSO_4$, dehydrated in a current of dry air below 300°, is quickly retransformed into gypsum, in contact with H_2O. Dehydrated above 300°, it takes up H_2O with extreme slowness. Chassevant finds that this latter result may be obtained at much lower temperatures, e.g. 150°, if a current of water vapor is used as a catalyst. This appears to be the mechanism of the geological formation of anhydrite. I. J. Patton (Chem. Abst. 26, 1932, 2666)

Chirkov, S. K., 1935, Raspredelenie broma v vodno-sil'vinitovoi sisteme (Distribution of bromine in water-sylvinite system): Kalii (U.S.S.R.), 4th year, no. 10, p. 19-24. (Russian text)

The systems: $KCl-KBr-H_2O$; $NaCl-NaBr-H_2O$ and $KCl-NaCl-K(Na)Br-H_2O$ were studied in the process of isothermic evaporation, and in the process of cooling their saturated solution at a low concentration of the bromides. The equations of distribution of Br and graphs are given. The rate of crystallization affects the distribution of isomorphous substances in the way that the amount of negatively adsorbed component increased in the solid phase with the increased speed of crystallization. A. Pestoff (Chem. Abst. 30, 1936, 2833)

__________ 1937, Soderzhanie ioda i broma v Solikamskikh karnallite, sil'vinite, sil'vine i galite (Iodine and bromine contents of Solikhamsk carnallite, sylvinite, sylvite, and halite): Kalii (USSR), 6th year, no. 9, p. 21-28. (Russian text)

The relation between the I and Br contents of sylvite and of halite in sylvinite is expressed by empirical mathematical equations. The distribution of Br in carnallite seams varies, but increases with the purity of the mineral. The quantity of Br present depends on the sequence of the carnallite layers. A curve is given showing the variation with depth of the Br content (0.15-0.25%) of Solikhamsk carnallites. With sylvinites the Br present increases with the sylvite content and falls progressively with the depth of the deposit. B. C. P. A. (Chem. Abst. 32, 1938, 8303)

Clements, Thomas, 1954, Geomorphic classification of desert types (abs.): Geol. Soc. America Bull., v. 65, no. 12, pt. 2, p. 1240-1241.

A geomorphic classification of types of desert topography has been developed as the result of several years' work by the author and his colleagues in the hot, dry area of southwestern United States. These types are distinctive and can be recognized in other hot deserts of the world and probably in the warm deserts as well. The classification is as follows:

(1) Playas: the flat or nearly flat low part of an enclosed basin. Playas can be subdivided into (a) dry, (b) moist, (c) crystal body, (d) compound, and (e) limepan.

(2) Desert Flats: the essentially flat surfaces extending from the edges of the playa to the alluvial fans or the bajadas.

(3) Alluvial Fans: the fan- or cone-shaped deposits at the mouths of canyons.

(4) Bajadas: alluvial aprons resulting from the coalescing of alluvial fans.

(5) Bedrock Surfaces: results of erosion, and subdivided into (a) pediments, (b) desert domes, and (c) hammadas.

(6) Dry Washes: stream-formed, but occupied by streams only at rare intervals.

(7) Dunes: accumulations of wind-blown sand.

(8) Badlands: soft deposits of any type eroded into rugged topography by sudden, heavy, but infrequent rains.

(9) Regions Bordering Through-flowing Streams: desert areas traversed by rivers rising in humid regions.

(10) Desert Volcanics: Recent or Pleistocene volcanics occurring commonly in desert areas, although not genetically related to the desert.

(11) Desert Mountains: mountains separating or bordering desert basins. (Author's abstract)

Clifton, R. L., 1944, Paleoecology and environments inferred for some marginal Middle Permian marine strata: Am. Assoc. Petroleum Geologists Bull., v. 28, p. 1012-1031.

The environment prevalent in modern marine seas limits the distribution of biologic assemblages in those seas. Since conditions of the environment can only be inferred for seas that no longer exist, it is obvious that comparisons with the seas of today are important in developing criteria by which to reconstruct conditions of environment for ancient seas. Blaine and Dog Creek deposits [which occur in Kansas, Oklahoma, and Texas] include strata from which the remains of both plants and animals have been recognized. (Author's abstract, partial)

Cole, L. H., 1915, Report on the salt deposits of Canada and the salt industry: Canada Dept. Mines, Mines Branch 325, 152 p. + index, 8 p.

__________, 1930, The salt industry of Canada: Canada Dept. Mines, Mines Branch 716, 116 p.

The salines of Canada occur in four areas: Maritime Provinces, southern Ontario, in a belt from Winnipeg to Great Bear Lake, and in Western British Columbia. Ontario is the largest supplier. There are large salt springs in the Prairie provinces. W.B.L.

Contreras V., Hugo, and Sansores, Enrique, 1953, Geologia del domo salino de "El Rosario" en el estado de Tabasco y sus posibilidades petroliferas (The Geology of the El Rosario salt dome in the state of Tabasco and its petroleum possibilities): Asoc. Mexicana Geol. Petroleos Bol., v. 5, no. 1-2, p. 57-74. (Spanish text and abstract)

Outlines the geology and oil possibilities of the Rosario salt dome in the state of Tabasco, Mexico. Data based partly on wells drilled on crest and western side of dome and on comparison with known information of two oil fields to the northwest. The wells traversed both the anhydrite caprock and the faulted Miocene and Oligocene formations which overlie it.

Cordini, I. R., 1948, Contribucion al conocimiento de los cuerpos salinos de la Argentina; 1. sulfateras del departamento General Lavalle (Mendoza) [Contribution to the knowledge of the salt deposits of Argentina; 1. salt pans of the General Lavalle department (Mendoza)]: Asoc. Geol. Argentina, Rev., t. 3, no. 3, p. 145-200. (Spanish text) (Reprinted as: Argentina Dir. Minas y Geologia Bol. 65, 1948, 53 p.)

A study of the saline bodies of Argentina; 1, salt pans of General Lavalle department, Mendoza province. The area is one of sand dunes on Quaternary and Recent sediments, the dunes separated by meandering streams principally abandoned and dotted by the salt pan deposits. Three of the larger of these are described in detail, but exploitation is not recommended because the reserves are small and the material of a type requiring expensive handling. (G.S.A. Bibl., v. 13, 1948, 59)

_________, 1950, Contribucion al conocimiento de los cuerpos salinos de Argentina (Contribution to knowledge of the saline deposits of Argentina): Rep. Argentina, Ministerio ind. y com., Dir. gen. ind. minera, Anales 3, 85 p.

A detailed account of many deposits, some of which are worked for NaCl and Na_2SO_4. Many chemical analyses of salines, brines, waters, and limestones are given, and possible methods of exploitation are discussed. Michael Fleischer (Chem. Abst. 47, 1952, 12149)

Crumpton, C. F. See Swineford, Ada, 1954.

Currie, J. B., 1956, Role of concurrent deposition and deformation of sediments in development of salt-dome graben structures: Am. Assoc. Petroleum Geologists Bull., v. 40, p. 1-16.

The mechanics of graben development over deep-seated salt domes are described and illustrated by results of sectional-model experiments and study of the Heidelberg field, Mississippi. Relative vertical uplift of the salt produces graben structures in the overlying sediments. Within these structures downward movement of rock material occurs by wedge-shaped blocks. Fault movement at one boundary of a block is accompanied by similar movement along one or more fault planes at the opposing margin of the wedge. Increase of fault throw with depth and abnormally thick sections in graben blocks constitute effects impressed on the geometry of graben structures by deposition of sediments during deformation of the underlying strata.

The results of two sectional-model experiments originally recorded on motion picture film are illustrated by eight photographs taken from individual frames. These experiments demonstrate the concentration of faulting in the upper beds over the crest of the salt uplift as deformation continues, relative age of faults, upward termination with consequent inactivity of the outer faults located at the margin of graben structures, and changes in fault dip as structural development proceeds. (Author's abstract)

Dabell, Harold, 1931, Salt occurrences in Egypt: Inst. Petroleum Technologists Jour., v. 17, p. 346-348.

Describes the occurrences of salt in prospect wells drilled in eastern Egypt. The salt, which has no known outcrop, is believed to be of middle and upper Miocene age. Small quantities of potash are reported in places. The salt is associated with beds of gypsum. W.B.L.

Danilova, V. V., 1949, K sodershchaniiu ftora v porodakh (Content of fluorine in rocks): Akad. Nauk S.S.S.R., Trudy Biogeokhim. Lab., no. 9, p. 129-134. (Russian text)

Numerous F analyses are cited. High F ($3.5 \times 10^{-2}\%$) is found in acidic massive crystalline rocks, while the basic forms are low in F ($2.85 \times 10^{-2}\%$). In volcanic rocks the basic specimens contain $4 \times 10^{-2}\%$ F, while the acidic and neutral ones contain $1.26 \times 10^{-2}\%$. In sedimentary rocks dolomites and limestones contain $2.39 \times 10^{-2}\%$, while gypsum and anhydrites contain $1.33 \times 10^{-2}\%$. Specimens were taken from various regions of U.S.S.R. G. M. K. (Chem. Abst. 47, 1953, 7388)

D'Ans, J., and Kühn, R., 1940, Über den Bromgehalt von Salzgesteinen der Kalisalzlagerstätten (The bromine content of the rock salt of the potash salt deposits): Kali, v. 34, p. 42-46, 59-64, 77-83. (German text)

$Br_{NaCl}: Br_{KCl}: Br_{carnallite} = 1:10:13.3$. The authors discuss the transformation relationship of the deposits in order to determine if there is a regular variation in Br content of different deposits: (1) The Br content of primary rock salt deposits of different districts showed a variation between 0.005 and 0.04%. The primary rock salts contain varying concentrations of NaCl, $MgCl_2$, and KCl. (2) Results are given and plotted for the variation in Br content for the NaCl-KCl system as in the sylvinite group from various districts. The sylvinites contain KCl and NaCl with smaller concentrations of $MgSO_4$ and $CaSO_4$. (3) The Br content of the carnallite deposits is given by the following relationship: $Br_{NaCl}: Br_{KCl}: Br_{carnallite} = 1:10:13.3$. The Br content of the NaCl-carnallite system is given and plotted. Br-content measurements on the carnallites are inaccurate if traces of $MgCl_2$ are present. (4) The kainite system contains varying proportions of kainite, rock salt, and sylvinite. The Br contents for kainite deposits of various districts are tabulated and given by the relationship $Br_{rock\ salt}: Br_{kainite}: Br_{sylvite} = 1:1.9:4.7$. Pure kainite deposits contained even higher concentrations of Br. Rock salt deposits from different parts of the country contain the above minerals in varying concentrations according to the locality. The possibility of separating the different constituents by fractional crystallization is considered. (Chem. Abst. 35, 1940, 2823)

Debyser, Jacques, 1952, Observations sur le milieu anaerobie de la lagune Ébrie (Côte d'Ivoire): [Observations on the anaerobic condition of the Ébrie lagoon (Ivory Coast)]: Acad. Sci. Paris Comptes rendus, v. 235, p. 1238-1240. (French text)

Description of anaerobic conditions in the lagoon of Ébrie, Ivory Coast, French West Africa; a section on sedimentation is included. It is noted that the hydrologic, bacteriologic, and sedimentation features of the lagoon are comparable to those which must have obtained during formation of oil-bearing shoestring sands of Oklahoma and Kansas. A.N.W. (Ann. Bibl. Econ. Geol., v. 25, for 1952, no. 2, 1954, 129)

Delecourt, Jules, 1946, Géochemie des oceans, des bassins clos et des gîtes salifères - mers et lacs contemporains (Geochemistry of the oceans, closed basins, and salt deposits -- contemporary seas and lakes): Soc. belge géologie Mem., Ser. in octavo, no. 1, 177 pp. (French text)

Review of worldwide occurrences with 75 references.

Dellwig, L. F., 1955, Origin of the Salina salt of Michigan: Jour. Sedimentary Petrology, v. 25, p. 83-110.

The purpose of this study was to determine the manner of deposition of the Salina salt, including the approximate temperature of deposition and the origin of the dolomite-anhydrite laminae.

Specimens were obtained from drill cores from the Michigan basin and from the Detroit mine of the International Salt Company. The bulk of the data was obtained through thin section study and this was supplemented by the examination of polished slabs, water-insoluble residues, and sections of core from which the salt had been dissolved.

Pyramidal shaped hopper crystals of halite comparable to those crystals produced in the manufacture of grainer salt and those formed in the manufacture of solar salt, were identified in the Salina salt. The pyramidal forms were outlined by liquid inclusions, and from these inclusions the temperatures of formation were determined as being between 32.0 and 48.4° C.

The salt was deposited in layers or bands of three distinct types: (1) cloudy layers of inclusion-rich pyramidal shaped hopper crystals of halite, (2) clear layers of inclusion-free halite, and (3) laminae of anhydrite and dolomite. These units are in part obscured in the recrystallized salt.

The alternation of bands of clear and cloudy halite was the result of temperature changes probably related to the seasons. The salt crystals, initially formed from the surface, grew as pyramidal shaped hoppers. Until the brine became saturated, settling hopper crystals accumulated on the bottom of the basin to form a layer of cloudy salt. With subsequent cooling the brine passed into the supersaturated state and settling hopper crystals provided nuclei for clear overgrowths. These crystals which grew on the bottom of the basin are inclusion-free and form the layers of clear salt. The return of higher temperatures followed again by lower temperatures would cause a repetition of this sequence. This cycle could have been interrupted at any time by the addition of brine to the basin or by periods of unusual climatic conditions.

The deposition of the anhydrite-dolomite laminae may be considered to have been the result of the influx of normal seawater. The addition of brine to the basin as a surface layer would have permitted the maintenance of life in this brine until the concentration reached the point at which mass extermination took place. Subsequent decomposition of the remains caused reducing conditions to develop in the basin and iron precipitated as pyrite. Indicative of this influx is the association with the laminae of carbonaceous material, pyrite, and a petroliferous odor and the lack of a recognizable relationship between the clear or cloudy salt and the anhydrite-dolomite laminae. Iron associated with the halite layers is in the form of hematite, indicating that oxidizing conditions were normal for the basin. (Author's abstract)

Desjardins, Louis, 1952, A new prospecting tool; aerial photos of multiple surface faults may locate deep-seated salt domes: Oil and Gas Jour., v. 51, no. 13, p. 82-84.

"A new prospecting tool for the Gulf coastal plain is the photogeologic study of multiple, closely spaced surface fault or fracture lines. The patterns formed by the lines bear a definite relationship to deep-seated salt domes and to the known subsurface faults of the region. These lines are revealed by careful analytical study of aerial photographs."

Dole, R. B., 1912, Potash in Nebraska: U.S. Geol. Survey Press Bull. 82, p. 2.

Reports that interest has been aroused in the discovery of soluble potash salts in certain lakes in western Nebraska. Samples were first submitted to U.S.G.S. by Carl Modessitt. Dole visited Jesse Lake.

Douglas, R. J. W. See Bostock, H. S., 1957.

Dunlap, J. C., 1951, Geologic studies in a New Mexico potash mine: Econ. Geology, v. 46, p. 909-923.

Langbeinite and sylvite occur in the same stratigraphic interval with abrupt and unexplained changes in their proportions. The highest concentrations of K minerals were found where a halite marker bed was farthest from a marker bed of clay above. It is suggested that the K minerals were precipitated in small open basins above the precipitated NaCl. Michael Fleischer (Chem. Abst. 48, 1954, 2531)

Dupouy-Camet, Jacques, 1953, Triassic diapiric salt structures, southwestern Aquitaine basin, France: Am. Assoc. Petroleum Geologists Bull., v. 37, p. 2348-2388.

The Aquitaine basin of southwestern France extends 190 miles along the north side of the Pyrenees and 230 miles along the Atlantic Ocean. It spreads over 35,000 square miles and is filled with nearly 30,000 feet of sediments above the basement of pre-Hercynian rocks. Above the continental Carboniferous and Permian, the Triassic consists of a lagoonal evaporite sequence of dolomite, gypsiferous clay, salt, and anhydrite. The maximum undisturbed thickness of the "Trias" is 7,000 feet. Inasmuch as the Trias is overlain by 8,500-23,000 feet of limestone and marl beds, it is unstable and where affected by the tectonic phases of the Pyrenees it has been thrust or intruded upward to the surface in the form of salt domes, piercement folds, and salt dikes along fault planes. These diapiric salt structures are grouped together under the generalized name of "accidents diapiriques" by the French geologist.

The diapiric salt structures of the southwestern part of the Aquitaine basin may be classified as follows.

1. Isolated salt domes--roughly oval with the long axis parallel with the Pyrenean structures. Have a cap of clay and gypsum. Rocks on the flanks are tilted up to 90°, and in places are overhung by the Trias; locally, there are blocks of the surrounding beds (Jurassic) imbedded in the salt mass.

2. Piercement folds with Triassic salt plug--the northern flank is downfaulted and broken. The Trias is injected along a fault up to the surface.

3. Anticlines with deep diapiric plug--discovered by drilling. At. St. Marcet, the diapir bears a cap of Cretaceous sedimentary conglomerate, which is a reservoir of an important gas field.

4. Large Triassic massives--formed at the junction of various fractures.

5. Diapiric salt dikes along faults--like dikes, overturning the flanks at the surface.

6. Erratic outcrops--probably in connection with invisible faults.

All these various diapiric features are connected with deep fractures of the Hercynian basement which are reflected in the cover. The difference of density and plasticity of salt might explain the uplift of the isolated domes as in the Gulf Coast of Louisiana and Texas. The Pyrenean orogenic phases played a leading part in the formation of the anticlinal structures. In most diapiric structures, both orogenesis and differences in density have combined to influence their growth. The study of unconformities and sedimentary conglomerates permits one to conclude that the uplift of the Trias has been discontinuous and connected with the various Pyrenean phases. The upthrust of the diapirs to the surface was generally at the end of Oligocene (Aquitainian).

The Trias upthrust has provided migration channels for hydrocarbons, and numerous asphalt seeps have long been known on the flanks of the diapirs or in the Miocene sediments overlapping them. Some deep wells have been drilled on the flanks of the deep or outcropping domes or to the cap rock in order to explore the sedimentary conglomerate formations. Almost all these wells encountered impregnations of asphalt and of very heavy oil, but no commercial production. However, at St. Marcet, an important gas field was discovered in 1939 which yielded 23.7 million cubic feet of wet gas per day in 1950, and at Lacq an oil dome without any connection with Triassic salt structures was discovered in 1949, which yielded 5,400 BPD, in May, 1951. (Author's abstract)

Eardley, A. J., 1938, Sediments of Great Salt Lake: Am. Assoc. Petroleum Geologists Bull., v. 22, p. 1305-1410. See p. 1359-1387.

An investigation of the sedimentary environment of the lake based on its origin, topography and hydrography of the area draining into the lake. H.T.M. (Ann. Bibl. Econ. Geol., v. 11, 1938, 263)

Egorov, V. V. See Kovda, V. A., 1954.

Epshtein, V. V., and Anferova, L. V., 1950, Godovye tzikly izmenenii mineralizatzii rapy ozera Karachi (Annual cycles of the mineralization of the natural brines of Lake Karachi): Akad. Nauk S.S.S.R. Doklady, Novaya seriya, tom 72, p. 65-68. (Russian text)

A report on the annual cycles of mineralization in Lake Karachi based on a study of the lake for 12 years. Three diagrams showing the cycles are provided. The salts considered are Na_2SO_4, $MgCl_2$, and NaCl. Gladys S. Macy (Chem. Abst. 45, 1951, 2275)

Escher, B. G., and Kuenen, Ph. H., 1929, Experiments in connection with salt domes: Leidsche Geol. Mededeelingen, Deel 3, Afl. 3, p. 151-182. (English text)

The origins of salt domes are referred to two classifications: The Lachmann-Arrhenius-Harbort theory based on isostasy and the Stille theory of tectonic force. Experiments were made in a special apparatus to test the theories by loading bedded materials of different plasticity and forcing them into vertical cylinders, either by free movement or opposed by a counter pressure of half value. The authors' conclusion is that salt dome formation may be fully explained by Lachmann's theory of isostatic adjustment by displacement of the lighter salt. Fully illustrated. W.B.L.

Feigel'son, I. B. See Bergman, A. G., 1953.

Feodot'ev, K. M., 1949, Geokhimicheskaya diagramma solyanikh otloshchenii (Geochemical diagrams of salt deposit): Akad. Nauk S.S.S.R. Doklady, Novaya seriya, tom 66, p. 239-241. (Russian text)

Diagrams are given representing the sequence and magnitude of salts deposited (1) of marine origin and (2) of sulfate-free brine. The method of diagramming is then applied to the K salt deposits of the Gaurdaksky Mountain area. C.H.F. (Chem. Abst. 48, 1954, 5036)

Flynn, A. E., 1951, Industrial mineral resources of Nova Scotia: Nova Scotia Dept. Mines and Nova Scotia Research Foundation, Conference on Industrial Minerals, /Proc./, p. 11-25. See p. 12-14.

Salt springs are numerous in Nova Scotia. At Malagash, beds of salt which occur near the surface are mined to a depth of 1,300 feet. To improve the appearance and purity of the crude salt, it is processed by grinding and flotation. In this process much of the included carbonaceous material is removed. Prospecting by drilling has also found salt at other localities. At Falmouth, an 11 foot bed was intersected at 543 feet. At Mabou, salt beds were encountered at 1,395 feet and were not bottomed at 5,579 feet, giving a salt interval of more than 4,184 feet. At Nappan, 4,812 feet of salt were penetrated. The test holes at Nappan are now used to produce brine from which the salt is removed in a modern evaporating plant. Salt has also been found in the Provinces of New Brunswick and Prince Edward Island. W.B.L.

Free, E. E., 1912, An investigation of the Otero basin, New Mexico, for potash salts: U.S. Dept. Agr., Bur. Soils, Circ. 61, 7 p.

Calcium sulfate salts with only minor associations of sodium or potassium are present in the Otero (Tularosa)basin. W.B.L.

Frei, A., 1954, Die mineralien der Schweizerischen gips- und anhydritlagerstätten (The minerals of the Swiss deposits of gypsum and anhydrite): Schweizer. min. pet. Mitt., v. 34, p. 280-299. (German text)

Glauberite was found for the first time in Switzerland.

Friend, J. N., and Allchin, J. P., 1940, Blue rocksalt: Nature (London), v. 145, p. 266-267.

Blue halite from Stassfurt, Germany, contained 23 ppm Au. Blue anhydrite from Cropwell Bishop, England, contained 4 ppm Au.

Gale, Hoyt, 1917, Potash in 1916: U.S. Geol. Survey Mineral Resources of the United States, 1916, Pt. 2, p. 73-171.

Reports that the first large production of domestic (U.S.) potash has come from the alkali lakes of western Nebraska (p. 85-90 deal with Nebraska). Ascribes origin of potash to leaching of ash from burned vegetation and from decayed vegetation. Reports total dissolved salts and K_2O for a number of samples. Describes plants and workings of five companies.

Gawel, Antoni, 1955, Złoza gipsu w Polsce południowej (Gypsum deposits in southern Poland): Cement Wapno Gips (Czerwiec), rok 11/20, nr. 6, p. 117-122. (Polish text)

The origin of gypsum deposits around Nida, Busko, Lopuszka, Mielec, Skorocice, and Carpathian Mountains in southern Poland are described. In the area of sub-Carpathian Miocene, greenish sandy loams in a thickness of approximately 50 m. were deposited. The shallow lagoons (formed from the receding sea) became concentrated (up to 6% NaCl) so that the gypsum started to crystallize. Its crystals a few cm. long cemented sand which was being deposited at the same time. The deposition of gypsum stopped when the concentration of water reached 22.5% NaCl. Afterwards, loams without gypsum deposited again, probably because of the dilution of the lagoon water with fresh sea water. It is also possible that the concentration of the lagoon water, instead of being diluted, was further concentrated above 22.5% NaCl; such a concentrated solution of NaCl dissolved gypsum from the deposits. A deposit of NaCl followed. However, where NaCl was not deposited, rich deposits of anhydrite, as in the region around Mielic, or gypsum, as in Lopuszka, were laid. Later the receding sea left lagoons which on evaporating to 6% NaCl started to deposit gypsum. However, the lagoons were continuously diluted by fresh sea water, so that the deposition of gypsum lasted geologically very long. This enabled the crystals of gypsum to grow upwards and reach even 3 m. in height, as in the region of Nida. Some of the gypsum deposits underwent a secondary recrystallization, as in the region of Busko and in the region of Lopuszka. In the latter one the secondary recrystallization was greatly intensified by the tectonic deformations which caused crevices in gypsum layers. The crevices were later on filled with fresh gypsum. The fresh part of the crystals are either fully transparent or yellowish-brownish. They do not contain any traces of loam in the main layers. The color and luminescence of these fresh crystals indicate the presence of traces of bituminous substances which must have circulated in the crevices at a later phase. Gypsum deposits in the region of Skorocice contain underground caverns formed by dissolving part of the gypsum layer by water. F. J. Hendel (Chem. Abst. 49, 1955, 13037)

Geilmann, W. and Berttlingek, H., 1942, Zur Bestimmung kleinster Mengen Jod in Salzen (Determination of traces of iodine in salts): Mikrochemie, v. 30, p. 217-225. (German text; French abstract)

Seven sylvinites and sylvites contained 0.00 to 0.59 γ of I/100 g salt. (Chem. Abst., 37, 1943, 3696)

Gentner, W., Präg, R., and Smits, F., 1953, Altersbestimmungen nach der Kalium-Argonmethode unter Berücksichtigung der Diffusion des Argons (Age determination by the potassium-argon method with allowance for the diffusion of argon): Zeitschr. Naturforschung, Band 8A, Heft 3, p. 216-217. (German text)

In a previous investigation of the Buggingen potash deposits, it was shown that the abundance of radiogenic argon in different layers varies, within narrow limits, in comparison to the corresponding abundance of potassium. Measurements with a specially constructed mass spectrometer now show that the A^{40} content depends on crystal size, suggesting that the difference in argon content can be attributed to diffusion.

Gorbov, A. P., 1950, O kontinentalnom solenakoplenii v Kulundinskoi stepi (Continental salt concentrations in the Kulundina desert): Akad. Nauk S.S.S.R. Doklady, Novaya seriya, tom 71, p. 921-924. (Russian text)

The alluvial sediments in the depressions of east Kazakhstan, Altai, and Salair are mostly the products of glacial and interglacial water deposition. The arid climate is favorable for the formation of typical salt marshes and salt lakes. The chemical character of the salts is very variable. Chlorides and sulfates of Na prevail; the concentration of the salt waters also varies widely, from fresh water to supersaturated solutions. Halite, thenardite, mirabilite, natron, or gaylussite are typical crystalline products. Three lake groups of the Kulundina depression were investigated for their hydrological and chemical conditions: (1) those around the Bshivka Lake, (2) the basin of the salt desert with the weakly mineralizing Berdabai and Malinova lakes, and (3) the soda lake of Tanatar, with its salt marshes. The chemical character of the affluxing waters is typically sodic-carbonatic, with CO_3^{--} prevailing over Cl^- (ratio about 3.6), while in the lakes proper the CO_3^{--} and Cl^- concentrations are about equal. The sodium carbonate waters are originating from the strong leaching of the sands of the glacial and interglacial sediments, which are prevailingly arkose sands, with 30 to 60% feldspar and acidic plagioclase. These feldspars are derived from the effusive rocks of the Altai Ore Mountains, which were freighted by the glacial ice streams to the depressions. Actual surface waters (av. 120 analyses) confirm the theory of leaching of such alkaline primary rock debris: they are all of the $Na-CO_3$ type. The climatological conditions of the more arid period of interglacial time were more favorable for the production of Cl^-, SO_4^{--}, and Na^+, Mg^{++} solutions which are enriched in the end states of the salt lake deposits, while the higher humidity and cooler temperature conditions of the post-glacial recent period favor the Na_2CO_3 leaching from the desert bottoms. The chlorides are the salts of highest mobility in this natural differentiation cycle; they are followed by the less mobile sulfates, and last by the carbonates. W. Eitel (Chem. Abst. 45, 1951, 2378)

Goubeau, Josef, and Birckenbach, Luther, 1938, Untersuchung der Edelmetallgehaltes von Kalisalzlagerstätten (The precious metal content of potash salt deposits): Zeitschr. anorg. allg. Chemie, v. 236, p. 37-44. (German text)

The values given are for Au + noble [precious] metals and are expressed in mg. per ton. Determinations are made in the salts themselves, in solution residues and sludges, in the salt earths and in the minerals in the vicinity of these German K-salt deposits. The noble [precious] metal content in the salts themselves ranges from 0.1 to 3.4. The completely white salts, which contain very little insoluble matter, show the lowest content, while the discolored salts show the greatest amount of insolubles and the highest content of noble [precious] metals. The solution residues and sludges show 3.0-11.4 mg./ton and the earths from 3.6 to 13.7, while the average content of the minerals is 4.7, although one of these, the Zechstein limestone, shows an average of 60.3 mg./ton. H. Stoertz (Chem. Abst. 32, 1938, 4486)

Gracht, W.A.J.M. van Waterschoot van der. See Van Waterschoot van der Gracht, W.A.J.M.

Haapala, P. S., 1953, Morococha anhydrite: Soc. geol. Peru Bol., v. 26, p. 21-32. (English text; Spanish abstract)

Lenses of anhydrite up to 100 ft. thick occur below limestone that has been altered by formation of silicates, by serpentinization, and by recrystallization. Haapala believes that the anhydrite is of sedimentary origin and not a replacement product of limestone reacting with magmatic solutions. Michael Fleischer (Chem. Abst. 48, 1954, 9874)

Hage, C. O. See Lord, C. S., 1947.

Hance, J. H., 1914, Potash in western saline deposits: U.S. Geol. Survey Bull. 540-P, p. 457-469.

The author visited saline lakes, marshes, flats, and wells in the western arid region to test and sample their waters for potassium salts. Examinations were made, samples were collected and analyzed, and suggestions were given regarding the possible origin of some of the deposits.

Hanna, M. A., and Wolf, A. G., 1941, Gold, silver and other elements in salt-dome cap rocks: Am. Assoc. Petroleum Geologists Bull., v. 25, p. 750-752.

Results are presented of 6 spectrographic analyses of cap rocks. High Ca was found in 5, Pb in 2, Zn in 1 and Sr in 1. Medium Ca was reported in 1, Pb in 1, Zn in 3, Sr in 3, Fe in 2, Ba in 2 and Mn in 3. Low Pb was noted in 2, Sr in 2, Fe in 2, Ba in 3, Mn in 3, Cu in 1, Mg in 1 and Ni in 1. Traces of the following were identified: Mg, Si, As, Cd, Fe, Al, Cu, Ag, Ba, Pb, Ni and Zn. Alden H. Emery (Chem. Abst. 35, 1941, 7890)

Harbeck, G. E., Jr., 1955, The effect of salinity on evaporation: U. S. Geol. Survey Prof. Paper 272-A, p. 1-6.

The effect of salinity is to reduce evaporation but at the same time to increase the energy returned to the atmosphere by other physical processes, so that under equilibrium conditions a saline solution reaches a higher temperature than that of pure water. Because of the many variables, of which some are interrelated, it is impossible to define a simple relationship between salinity and the decrease in evaporation. The theory presented in this report is general, and for any given rate of evaporation from pure water, the effect of salinity on evaporation and the attendant temperature rise can be determined on the basis of measurements of air and water temperatures, humidity, and atmospheric pressure. (Author's abstract)

Harrison, J. V., 1930, Geology of some salt-plugs in Laristan (Southern Persia): Geol. Soc. London Quarterly Jour., v. 86, pt. 4, no. 344, p. 463-522.

Presents result of reconnaissance of southern Persia [Iran], with individual descriptions of numerous salt plugs exposing the Hormuz series considered to be of Cambrian age. W.B.L.

__________, 1931, Salt domes in Persia: Inst. Petroleum Technologists Jour., v. 17, p. 300-320.

A comprehensive outline of the occurrence of salt domes in Persia [Iran] with descriptions of many features, salt glaciers, solution cauldrons, solution valleys, the regional stratigraphy and descriptions of individual domes. There are discussions of the age of the salts and of salt domes, the plasticity and movement of salt, the salt supply and the volume involved. W.B.L.

Hartley, W. N., and Ramage, Hugh, 1897, On the spectrographic analysis of some commercial samples of metals, of chemical preparations, and minerals from the Stassfurth potash beds: Chem. Soc. London Jour., v. 71, p. 547-550. See p. 549-550.

The following Stassfurt minerals were examined: kainite, tachhydrite, sylvite, kieserite, stassfurtite, epsomite, and rock salt. Every specimen contained sodium, potassium, and iron but no rubidium or caesium. Calcium was present in all but stassfurtite and magnesium in all but sylvite and rock salt. Strontium was present in tachhydrite and epsomite, manganese in tachhydrite, and a trace of nickel in epsomite. The stassfurtite spectrum showed very strong boric oxide bands and a trace of copper.

Haslam, J., Allberry, E. C., and Moses, G. 1950, The analytical chemistry of bromine manufacture, Part II. Bromine content of the Cheshire salt deposit and of some borehole and other brines: Analyst, v. 75, p. 352-356.

Considerable analytical data show that although there is considerable variation of the salt and insoluble matter with the depth, the Br distribution is fairly constant. In representative brines the ratio of g. Br to g. Cl varies from 1:1310 to 1:1939. (Chem. Abst. 44, 1950, 8821)

Hayes, A. O., 1920, The Malagash salt deposit, Cumberland County, Nova Scotia: Canada Dept. Mines, Geol. Survey, Mem. 121, Geol. Ser. no. 103, 24 p.

Presents the physiography, stratigraphy, and structural geology of the Malagash salt area. Analyses and drill records are also provided. There are maps of Malagash Point and Nova Scotia showing the locations of salt springs. W.B.L.

Hazen, E. Cavaye. See Cavaye Hazen, E.

Hecht, Friedrich. See Koczy, F. F., 1957.

Hills, J. M., 1942, Rhythm of Permian seas -a paleogeographic study: Am. Assoc. Petroleum Geologists Bull., v. 26, p. 217-255.

Since the writer believes that an understanding of the physical history of the Permian period is fundamental to a sound classification of the rocks of this system, he has attempted to summarize the physical history of the Permian of the southern Mid-Continent with especial reference to the West Texas Permian basin. To this end seven paleogeographic maps are presented, drawn on the following horizons: latest Pennsylvanian (Thrifty), Wolfcamp (Coleman Junction), lower Leonard (Choza), San Andres (Blaine), middle Guadalupe (Grayburg), Castile and Salado, and Rustler. The regional correlations involved in making these maps are discussed in the text, and several supporting cross sections are illustrated. Some of the more prominent features of these maps are pointed out.

From the data on the areal extent of the seas, several curves have been constructed which show graphically many features of Permian history and throw much light on the physical basis for the classification of the rocks of this system. The text summarizes the history of the Permian in the southern Mid-Continent, and points out the relation of this study to the standard Permian section for North America set up by Adams et al. (Author's abstract, partial)

Hobson, R. A., 1948, Sampling of some lakes near Baladjie and Mt. Palmer for alunite: Western Australia Geol. Survey Rept. for 1945, p. 14-17.

Many analyses are given. No alunite was found at Baladjie. The lake at Mt. Palmer is estimated to contain 290,000 tons of material averaging 59% alunite.

Hoempler, A. L. O., 1953, Domos de sal en la Cordillera Oriental /Peru/ (Salt domes in the Cordillera Oriental /Peru/): Soc. geog. Lima Bol., tomo LXX, p. 77-82. (Spanish text)

Discusses salt domes in the Cordillera Oriental of Peru as to geology, stratigraphy, and structure.

Hofseth, Bjarne, 1931, Origin of Chilean nitrate: Eng. and Min. Jour., v. 131, p. 467-468.

The nitrogen content of the Chilean nitrate deposits is said to be principally from air transported nitrogenous dust derived from guano blowing in from the sea coast. Volcanic gases carried from the Cordillera also contributed to the supply. The nitrogenous material has combined with decomposition products of the volcanic rocks of the desert. The reviewer notes, however, that phosphates characteristic of guano deposits are absent in the nitrate fields. W.L.W. (Ann. Bibl. Econ. Geol., v. 4, 1931, 72)

Hoyos Ruiz, A. See Cavaye Hazen, E., 1953.

Hull, W. Q., 1952, Canada, new giant of the north: Chem. and Eng. News, v. 30, p. 2692-2697.

Reviews the possibilities of caustic soda and chlorine production in Canada by making use of some of the large resources of salt so far found in the western provinces. Notes that British Columbia's needs for raw salt may continue to be served from San Francisco Bay because of low transport costs. W.B.L.

Hume, G. S., 1947, The Interior Plains [Canada]: Canada Geol. Survey, Econ. Geology ser., no. 1, 3d ed. p. 189-219. See p. 216-217.

Salt is produced near Waterways, Alberta, and Neepawa, Manitoba. The salt at Waterways is considered to be Upper Devonian and was found at a depth of 694 feet. Thick salt beds occur in east central Alberta and contiguous Saskatchewan where approximately 500 feet of salt is at a depth of from 3,500 to 4,000 feet. The Neepawa salt was discovered in 1913 at a depth of 1,742 feet in a well. In 1932 the Neepawa Salt Company of Manitoba commenced pumping brine and evaporating it to produce salt.

Imlay, R. W., 1952, Marine origin of Preuss sandstone of Idaho, Wyoming, and Utah: Am. Assoc. Petroleum Geologists Bull., v. 36, p. 1735-1753.

Redbeds of the Preuss sandstone grade into fossiliferous near-shore marine sandstones and limestones. The redbeds and salt beds formed in a series of saline lagoons bordering a large island; the lateritic soils of the island were the main source of Fe oxide and sands for the Preuss sandstone. Marie L. Lindberg (Chem. Abst. 48, 1954, 1215)

Johns, R. K., 1954, Gypsum deposits southeast of Renmark: South Australia Dept. Mines, Mining Rev. 96 for half-year ending June 30, 1952, p. 45-48; Gypsum deposits -Blanchetown plain: ibid, p. 48-50.

The gypsum deposits are extensive but the grade is low. Analyses are given.

Joplin, G. A., Carter, E. K., and Burnett, J. K., 1954, Occurrence of sodium chloride and other soluble salts in the calcareous shales of Mt. Isa and Cloncurry, Queensland: Australian Jour. Sci., v. 17, p. 102.

A white incrustation on the weathered surface of Mt. Isa shales contained 66.1% NaCl, 8.55% $MgCl_2$, and 16.8% $MgSO_4$. Shale samples leached with distilled water gave a solution containing Na, Mg, Cl, and SO_4, although the rock contained only 0.05% solution material and 0.002% NaCl. J.F. Kefford (Chem. Abst. 49, 1955, 7461)

Kadysev, E. M. See Vorob'ev, A. L., 1951.

Karlik, Berta, 1939, Der Heliumgehalt von Steinsalz und Sylvin (The helium content of halite and sylvite): Mikrochemie, v. 27, p. 216-230. (German text).

A review. German and other samples studied. (Chem. Abst. 34, 1940, 593)

Kemeny, Etel, 1941, Uran- und Radiumgehalt von Steinsalz und Sylvin (Uranium and radium content of rock salt and sylvite): Akad. Wiss. Wien, Math.-naturw. Kl., Sitzungsber., v. 150, Abt. IIa, p. 193-207. (German text)

/German samples studied7 The U and Ra contents of rock salt, sylvite, and carnallite were measured. The average U contents of the tests were 6 x 10^{-10} g. per g., with no appreciable difference among the 3 salts. The average Ra contents were about 3 x 10^{-16} g. per g. Hans Schenkel (Chem. Abst. 37, 1943, 1927)

Koczy, F. F., Tomic, Ernst, and Hecht, Friedrich, 1957, Zur Geochemie des Urans im Ostseebecken (On the geochemistry of uranium in the Baltic Sea): Geochimica et Cosmochimica Acta, v. 11, p. 86-102. (German text; English abstract)

In order to study the geochemistry of uranium on typical shelf zones, samples of river water and sea water, as well as samples of sediment from the Baltic Sea region, have been examined......The uranium content of river water originating in regions of igneous rocks is low, averaging 0.5×10^{-6}g U/l. The uranium content of rivers from sedimentary rock regions seems higher by a factor of two or more, the maximum value found being 12.8×10^{-6}g U/l. It may be concluded that the uranium is more easily leached out from sedimentary regions. While the southern and eastern rivers supplying water to the Baltic Sea have not been investigated, it can be assumed that their uranium content is high, especially since the sea area surrounding the mouths of these rivers exhibits high uranium values.

The radium content of the river water is not in equilibrium with the uranium, amounting to only 10% of the latter. It is thus concluded that uranium is more soluble than radium.

The uranium content of water from the Baltic Sea is also variable, ranging from 0.77 to 5.9×10^{-6}g U/l. High salinity inflowing water shows 1.8×10^{-6}g U/l, while that of outflowing water is less averaging 0.9×10^{-6}g U/l. Except for the southeastern regions and deep water areas, a marked correlation of salinity and uranium content exists. An increase of deep water uranium content correlates with a surface water increase. Surface water increases can be explained by the high uranium content of inflowing river waters; high deep water values are correlated with an oxygen deficiency. Here it may be assumed that the uranium (VI) is reduced to uranium (IV) forming insoluble complex compounds with organic material. This settles slowly to the bottom, and explains the rather high uranium content of the sediment (values range between 3.2 and 10.3 x 10^{-6}g U/g; the normal content in clays is about 2 x 10^{-6}g U/g).....(Author's Abstract, partial)

Kovda, V. A., Egorov, V. V., Morozov, A. T., and Lebedev, Yu. P., 1954, Zakonomernosti protsessov solenakopleniya v pustynyakh Aralo-Kasppiiskoi nizmennosti (The mechanisms of the processes of salt accumulation in the deserts of the Aral-Caspian depression): Akad. Nauk S.S.S.R., Pochvennogo Inst. im V. V. Dokuchaeva, Trudy, tom 44, p. 5-78. (Russian text)

The authors cover the geologic history of the area from the point of view of the accumulation of salts, such as NaCl or $CaSO_4 \cdot 2H_2O$ /gypsum/, indicating that the process of salinization is still going on. The fresh waters, because of their relatively low specific gravity, stay on the surface of the ground waters which are saline. The authors discuss the rise of the brine waters from oil-bearing types of formation, which contain primarily chlorides with practically no sulfates. These brines give rise to fluffy solonchak. Its salts are carried by the winds to distant areas and come in contact with earlier continental deposits containing sulfates, giving rise to gypsum formation. The influence of the Caspian and Aral seas on the present-day accumulation of salts is discussed extensively, giving data on the relation of the composition of the waters of the rivers to that of the seas. They show that the continental type of salt inflow into these seas contributes to their high sulfate content. In the section on the role of the plant cover on the accumulation of salts in the area a thorough review is presented, giving some new data on the composition of the ash of plants growing under saline conditions in the area. Calculations are made on the annual salt contribution of these plants to the soil in terms of kg./ha. The next section discusses in detail the significance of the river waters in the accumulation of salts in the area, giving data on the composition of the respective rivers draining into the Caspian and Aral seas. This is followed by a discussion of the destiny of salts entering the depression, associating it with the mineralization of the ground waters in the geologic profile, followed by a review of the factors involved in this mineralization and the present status of the depression. From then on, the salts in the soil cover are discussed, their seasonal dynamics, relation to irrigation, and methods of amelioration, covering the different stages in the process of salinization, solonchak, solonetz, and solodi. In all sections considerable chemical data are presented to illustrate the points made. 45 references. J.S. Joffe (Chem. Abst. 49, 1955, 14604)

Krull, Otto, 1953, Die Entstehung der deutschen Kalisalzlager (The origin of German potash deposits): Deutsche Akad. Wiss. (Berlin) Wiss. Annalen, 2 Jahrg., Heft 9, p. 559-570. (German text)

A comprehensive review paper giving geological, chemical, and mining information on German potash deposits.

Kuenen, Ph. H. See Escher, B. G., 1929.

Kühn, Robert, 1955, Tiefenberechnung des Zechsteinmeeres nach dem Bromgehalt der Salze (Calculation of the depth of the Zechstein Sea from the bromine content of the salts): Deutsche geol. Gesell. Zeitsch., Band 105 for 1953, p. 646-653. (German text)

If it is assumed that the ocean contained the same amounts of Br and Cl in the Zechstein as now, the first NaCl, precipitated from solution containing 802 p.p.m. Br, is calculated to contain 32 p.p.m. Br; analyses of 4 samples show 70, 50, 29, and 42 p.p.m. Br. The Br content of the salt precipitated by evaporation is calculated on several different assumptions as to the course of crystallization and these are compared with values found by analysis for the Werra and Stassfurt deposits. The Br content of the salt decreases with increasing depth of crystallizing mother liquor. (Chem. Abst. 35, 1941, 2823; Baar, Chem. Abst. 48, 1954, 11263d)

____________, 1955, Über den Bromgehalt von Salzgesteinen, inbesondere die Quantitative Ableitung des Bromgehalte nichtprimärer Hartsalze oder Sylvinite aus Carnallitit (The bromine content of salt deposits, particularly the quantitative derivation of the bromine content of the non-primary hard-salt or sylvinite from carnallite): Kali u. Steinsalz (Essen), no. 9, p. 3-16. (German text)

Generalized mathematical expressions are derived for the Br content of salt minerals when Br-containing salts are dissolved and other salts simultaneously crystallized. The exact values depend on C_L/C_K for each salt involved, where C_L is Br (moles) /total halogen (moles) in the solution, and C_K is the corresponding ratio in each salt. The values for C_L/C_K are tabulated for halite, sylvite, carnallite, bischofite,

kainite, tachhydrite, rinneite, koenenite, and boracite. The tendency of the solutions to reach their Br equilibrium concentration is illustrated in the case of carnallite in contact with relatively Br-rich, and Br-poor solutions. The Br-exchange rate is greater with 0.1-mm. particles than with 3-4-mm. particles. Calculated Br contents for sylvite (Werra region), hard salt (south Harz district), and anhydrite-bearing sylvinite (from Königshall-Hindenburg) agree closely with reported analyses, and suggest the use of Br in establishing the history of salt formations. C. H. Fuchsman (Chem. Abst. 49, 1955, 12225)
(See also, D'Ans, J., 1940.)

Ladoo, R. B., and Myers, W. M., 1951, Nonmetallic minerals, 2d ed.: New York, McGraw-Hill Book Co., Inc., 605 p. See p. 436-453.

The chapter on salt discusses the geology, chemistry, mineralogy, chemical composition, and occurrence of salt deposits, chiefly, in the United States but with brief mention of some foreign occurrences as well. The chapter also includes other information on the salt industry, such as, United States and world production, marketing, extraction processes, and the treatment of artificial and natural brines.

Landes, K. K., 1945, The Salina and Bass Island rocks in the Michigan basin: U. S. Geol. Survey Oil and Gas Invs. Prelim. Map no. 40, text on map, scale approx. 1 in. to 23 mi.

"Enough wells have now been drilled in the Michigan basin to make possible the preparation of regional thickness and structure maps of the upper Silurian Salina and Bass Island formations... This report describes the distribution, thickness, and character of the rocks in the Salina and Bass Island formations. It is based mainly on the study of rock cuttings obtained by the drilling of wells....

"The investigation has furnished new information on: (1) the possibilities for oil and gas in the Salina and Bass Island rocks; (2) the extent and thickness of the salt beds of Salina age of Michigan and Ontario; and (3) the structural effects of large scale leaching of salt around the rim of the Salina salt basin." (Author's introduction, partial)

Lang, W. B., 1957, Annotated bibliography and index map of salt deposits in the United States: U. S. Geol. Survey Bull. 1019-J, p. 715-753.

Salt is abundant in the United States. Though of vital importance for domestic purposes in historic times, it has now become one of the most important commodities in industry and the demand for large tonnages of raw salt for industry is steadily increasing. The purpose of the bibliography is to serve as a ready reference to a wide range of subjects on salt which include the geographic distribution of salt deposits, geologic description of occurrences, geophysical exploration, technology, experimental research, and historical accounts. [The bibliography covers references to June 1956.] (Author's abstract)

Lapidus, Alberto, 1948, El yeso de Entre Rios (Gypsum in Entre Rios): Industria Minera (Camara Argentina de Mineria), año. 7, no. 79, p. 12-14, 1 fig. (Spanish text)

Entre Rios is the second largest producing area for gypsum in Argentina. The possibilities of the area have not been fully explored as yet. The gypsum occurs interbedded in clays of the Pampeano formation (Tertiary - Quaternary). (G.S.A. Bibl., v. 13, 1948, 160)

Lebedev, Yu. P. See Kovda, V. A., 1954.

Lees, G. M., 1931, Salt - Some depositional and deformational problems: Inst. Petroleum Technologists Jour., v. 17, p. 259-280.

In the Near East, saline formations are of widely separated geologic ages. In Persia [Iran] and Iraq salt is in the Miocene Lower Fars or the Cambrian Hormuz series. Massive gypsum beds occur in the Eocene, Cretaceous, Jurassic, and Triassic. In India, salts are found in the Eocene and Cambrian; in Palestine there are gypsum beds in the Miocene and Pliocene. The Jebel Usdum salt dome is pre-Pliocene. The Dead Sea also is a source of salt. In Egypt, the Miocene contains salt and gypsum and at the lower end of the Red Sea are salt domes of possible Triassic age.

The salt domes of southern Persia [Iran] have been extruded to heights of 4,000 feet above the plain and in some places plastic glaciers of salt have formed. The low annual rainfall of 2 inches has permitted these isostatically balanced columns of salt to remain standing. It is believed that pressures required in the laboratory to cause flowage are greater than those necessary under natural conditions. W.B.L.

Levchenko, T. F. See Aleksandrov, G. P., 1953.

Lindberg, M. L., 1946, Occurrence of bromine in carnallite and sylvite from Utah and New Mexico: Am. Mineralogist, v. 31, p. 486-494.

A g. sample of saline minerals was dissolved in 4 ml. water, filtered, and washed with 1 ml. water, 3 ml. concentrated H_2SO_4 was added and 1 ml. CCl_4 to test for I (violet color). Cl water was then added to test for Br (amber color). Carnallite and sylvite from Eddy County, New Mexico contain 0.1% Br and those from Grand County, Utah 0.3% Br. No Br was detected in halite, polyhalite, langbeinite, or anhydrite, nor was any I found. (Chem. Abst. 40, 1946, 7103)

Liversidge, A., 1897, Presence of gold in natural saline deposits and marine plants: Chem.Soc. London Jour., v. 71, p. 298-299.

Both gold and silver were found in rocksalt, sylvite, bittern, seaweed ashes, kelp, and oyster shells.

Lopez de Azcona, J. M. See Mir Amoros, Jesus, 1948.

Lord, C. S., 1951, Mineral industry of the district of Mackenzie, Northwest Territories: Canada Geol. Survey Mem. 261, 336 p. See p. 63.

"Salt has been reported from Cambrian, Ordovician, and Silurian strata in the Mackenzie River and Western Great Slave Lake areas (See Correlation Chart and Table of Formations, p. 30). It is commonly associated with gypsum. None has been extracted.

"Salt springs occur along the foot of an east-facing escarpment on Salt River west of Fort Smith. The brine is a saturated salt solution wherein the contained solids are almost entirely sodium chloride. About 4 tons of salt were formerly collected from these springs annually. (Cameron, 1922, pp. 17, 42, 43).

"A well drilled for oil at Windy Point on the north shore of Great Slave Lake penetrated four salt beds between depths of 1,070 and 1,380 feet. The total estimated thickness of these beds is about 60 feet. They are associated with gypsum, anhydrite, and red shale possibly of Silurian age (Cameron, 1922, pp. 16, 43)."

Lord, C. S., Hage, C. O., and Stewart, J. S., 1947, The Cordilleran region [Canada]: Canada Geol. Survey, Econ. Geology ser., no. 1, 3d ed., p. 220-310. See p. 309.

Records the occurrence of sodium and magnesium salts in small undrained lakes in the areas around Clinton, Chilcotin, Ashcroft, Kamloops, and Okanagan in the moderately arid interior of British Columbia. Last Chance Lake, 16 miles north of Clinton, contains a permanent deposit of crystalline salts interbedded with mud. The crystal masses range from 4 to 70 feet in diameter and are from 1 to 10 feet thick.

Lucas, P. T. See Briggs, L. I., 1954.

Luk'yanova, E. I., 1953, O solyakh Sarykamyshchskoi kotloviny (Salts of the Sarykamyshskaya basin): Akad. Nauk S.S.S.R. Doklady, Novaya seriya, tom 92, p. 769-771. (Russian text)

The distribution of salt deposits in the Sarykamyshskaya basin in Turkmen S.S.S.R. is described in detail. The lakes of the area are fed with highly mineralized streams, and the enrichment of the deposits with time is to be expected. The dust deposits of the area contain some 39.4% Na_2SO_4, 4.98% $CaSO_4 \cdot 2H_2O$, and 55.5% insolubles. Mirabilite deposition was established in the waters of the region. The lakes of the region contain the following deposits: surface salt layers of 68.2% NaCl and 23.35% $MgCl_2 \cdot 6H_2O$, with mother liquor of 6% concentration; a deeper salt layer (35 cm.) contains 94.3% NaCl and 0.91% $CaSO_4 \cdot 2H_2O$; while a deeper layer (1.25m.) contains 32.03% NaCl, 5.4% $CaSO_4 \cdot 2H_2O$, and 53.57% $Na_2SO_4 \cdot MgSO_4 \cdot 4H_2O$. The order corresponds to the soly. diagram of the system of NaCl-$MgCl_2$. G.M. Kosolapoff (Chem. Abst. 48, 1954, 5749)

Macdonald, G. J. F., 1953, Anhydrite-gypsum equilibrium relations: Am. Jour. Sci., v. 251, p. 884-898.

Thermodynamic calculations show that gypsum will break down to anhydrite plus water below 14° in the presence of a saturated NaCl solution. High salt contents lower the dehydration temperature. Gypsum will begin to precipitate out of a concentrated seawater solution at temperatures below 34°. Anhydrite is the first $CaSO_4$ to precipitate if the temperature is above 34°. Pressure acting equally on all phases raises the temperature of dehydration. A mean pressure acting on the solid phases 2.4 times as great as that acting on the liquid phases lowers the dehydration temperature. The depth to which gypsum will be found in nature will depend on the temperature gradient, composition of ground waters, and ratio of lithostatic to hydrostatic pressure acting on the $CaSO_4$ deposit. By using the gradient found over the Grand Saline Dome in Texas, assuming the ground water to contain 10% dissolved salts, the maximum depth at which gypsum is stable would be 1,360 feet in this locality. C. J. O'Brien (Chem. Abst. 48, 1954, 5029)

McGregor, J. J., 1954, Gypsum and anhydrite deposits in southwestern Indiana: Indiana Geol. Survey Rept. Progr. 8, 24 pp.

Gypsum and anhydrite occur intercalated with argillaceous and dolomitic limestone. An isopach map shows thicknesses up to 250 ft. Deposition was probably in partly closed basins. Michael Fleischer (Chem. Abst. 49, 1955, 7459)

Marcus, E. See Biltz, Wilhelm, 1909.

Masson, P. H., 1955, An occurrence of gypsum in southwest Texas: Jour. Sedimentary Petrology, v. 25, p. 72-77.

Gypsum in the form of crystals and rosettes of selenite has been found in subsurface clays and sands of the Laguna Madre mudflats of southwest Texas. The habit of the crystals is unusual, and the dominant crystallographic forms are $(\bar{1}11)$ and $(\bar{1}02)$. The manner in which the crystals grow larger at depth and become lens-like in shape also is of interest. It is concluded that the gypsum precipitates from highly saline seawater which periodically moves in wind-blown sheets across the surface of the mudflats and sinks into the underlying sediments. (Author's abstract)

Melchior, L. F., 1953, The geophysical discovery and development of the Bayou Couba dome [Louisiana]: Geophysics, v. 18, no. 2, p. 371-382.

The case history of the Bayou Couba Dome, St. Charles Parish, Louisiana, reports the results of seismic refraction, seismic reflection, and gravity exploration leading to the discovery of the dome. These data, together with the results of additional exploration done to define the dome, compare favorably with the actual dome shape to the extent it is determined by drilling. (Author's abstract)

Miller, A. H., and Norman, G. W. H., 1938, Gravimetric survey of the Malagash salt deposit, Nova Scotia: Am. Inst. Min. Met. Eng. Trans., v. 129, p. 372-380.

Gravimetric determinations were made over the immediate area of the salt mine. Although the results conform to the geologic structure and indicate the presence of another salt area, no computations of the hypothetical structure were made. The brief article is useful in outlining the local geology. W. B. L.

Mir Amoros, Jesus, 1946, Sobre el contenido en bromo de las sales potasicas de la cuenca del Llobregat (Barcelona) [The bromine content of potassium salts of the Llobregat basin (Barcelona)]: Inst. geol. y minero España Notas y comun. 16, p. 269-287. (Spanish text)

The deposit consists of alternating layers of sylvinite and halite 50-250 cm. thick. The sylvinite contains sylvite 36-52, halite 39-57, carnallite 1-4, kainite 2, anhydrite 1-3, and insolubles 0.5-1.5%. The NaCl contains 0.02-0.03% Br by weight; the KCl, 0.2-0.3%. A "fossilized" brine contained KCl 8.66, NaCl 11.80, $MgCl_2$ 8.42, $MgBr_2$ 0.79, $CaSO_4$ 0.47, and H_2O 69.86%; $d_{25} = 1.251$. The present data are compared with data on the Werra salt deposits. Cyrus Feldman (Chem. Abst. 42, 1948, 6714)

__________, 1947, Contribucion al estudio del problema de la sal comun azul (Contribution to the study of the problem of common blue salt): Acad. Cienc. Barcelona, Mem., epoca 3, no. 590, v. 29, no. 2, 48 p. (Spanish text)

Concludes that the blue color of halite crystals in the layers of common salt intercalated in the potash salt deposits of the Llobregat basin, Spain, is probably due to radioactive processes and that the salt is of secondary origin. Other features of common blue salt are discussed, and discussion by J. R. Bataller Calatayud is appended. (G.S.A. Bibl., v. 20, 1955, 366)

__________, and Lopez de Azcona, J. M., 1948, Sobre el contenido en plomo y en manganeso de la silvinita de la sal comun de la cuenca potasica del Llobregat (Spain) /On the lead and manganese content of the sylvinite and common salt of the potash salt deposits of Llobregat (Spain)/: Acad. Cienc. Barcelona, Mem., epoca 3, no. 602, v. 29, no. 14, 11 p. (Spanish text)

Reports the results of spectrographic analyses to determine the lead and manganese content of sylvinite and halite in the potash salt deposits of the Llobregat basin, Spain. (G.S.A. Bibl., v. 20, 1955, 366)

Moore, J. E. See Rawson, D. S., 1944.

Morozov, A. T. See Kovda, V. A., 1954.

Morton, Friedrich, 1955, Ueber das Grünsalz im Hallstätter Salzberge (On the green salt of the Hallstatt salt deposit): Oberösterr. Musealverein Jahrb., Band 100, p. 361-362. (German text)

Analyses of green salt from salt deposits of the Hallstatt region, Upper Austria, revealed the presence of tin in one part of the sample, in addition to Cu, Fe, Mn, and Ni. It is therefore concluded that formation of the green salt was due to alteration of bronze, which may prove to be of prehistoric origin. (G.S.A. Bibl., v. 20, 1955, 375)

Moses, G. See Haslam, J., 1950.

Mulligan, R. See Bostock, H. S., 1957.

Myers, W. M. See Ladoo, R. B., 1951.

Nelson, K. H. See Thompson, T. G., 1956.

Nikolaev, A. V., 1949, Kalii v prirodnykh vodakh i mekhanizm diffuzionnogo rasseyaniya elementov (Potassium in natural waters and the mechanism of diffusion of the scarce elements): Akad. Nauk S.S.S.R., Izvest. Sektora Fiz.-Khim. Anal., tom 17, p. 396-412. (Russian text)

A review of the possibilities of producing potassium from the waters of seas and lakes. For oceans and brines the ratio of NaCl/KCl is 33-37; for rivers, about 4; for the great interior lakes, 37-70; for the continental salt lakes, about 200; and for lakes with secondary potassium, 11-13. An increase of the potassium content of lakes Sultan-Sinzhar and Dzhaksi-Klich was observed; therefore, these lakes and the surrounding region should be investigated for potassium deposits. 30 references. Gladys S. Macy (Chem. Abst. 48, 1954, 8708)

Nikolaev, I. I., 1950, Biologicheskiya pokzateli osoloneniya Baltiskogo morya (Biological indicators of salt increase in the Baltic Sea): Priroda (Moscow), no. 5, p. 15-20. (Russian text)

Reviews various biological studies which indicate an increase in salt in the Baltic Sea.

Nikol'skaya, Yu. P., 1951, K voprosu soleobrazovaniya v prirodnykh vodakh i solyanykh ozerakh Kulundy (On the question of salt formation in the natural waters and salt lakes of Kulunda): Akad. Nauk S.S.S.R. Doklady, Novaya seriya, tom 80, p. 915-917. (Russian text)

The small valley contains 11 systems of chains of lakes and swamps joined by streams or springs. The distribution of the following 4 types of water is given in some detail: (1) $CO_3^{2-} + HCO_3^- > Ca^{2+} + Mg^{2+}$; (2) $CO_3^{2-} + HCO_3^- < Ca^{2+} + Mg^{2+} < CO_3^{2-} + HCO_3^{2-} + SO_4^{2-}$; (3) $CO_3^{2-} + HCO_3^- + SO_4^{2-} < Ca^{2+} + Mg^{2+}$; (4) $HCO_3^- = 0$. Water of the first lake of a chain is of type (1) containing $NaHCO_3$ and Na_2CO_3. Water of the second type (containing $MgSO_4$ and no Na_2CO_3) is found in the lakes that extend to the edge of the pine woods that cover the dell. The salts characteristic of the sulfate-chloride water of type (2) are derived from the weathering of the annual flora growing in the black soil of the steppe. V.H.G. (Chem. Abst. 48, 1954, 6053)

__________, 1955, Formirovaniya solyanikh ozer Kulundiniskoi stepi (Formation of the salt lakes of the Kulunda steppe): Akad. Nauk S.S.S.R. Doklady, Novaya seriya, tom 101, p. 525-527. (Russian text)

A comprehensive investigation of the hydrochemistry of the surface and subterranean waters in the area of the Kulunda steppe and their salt lakes was performed. There are typical carbonate waters, with Na_2CO_3 and $NaHCO_3$, sulfate waters, enriched in chlorides ($MgCl_2$), and related to seawater, and finally chloride solutions containing $CaCl_2$. One may speak of a real "metamorphism" of the natural waters (Kurnakov and Zhemchuzhnyi. Izvest. Akad. Nauk S.S.S.R. 6, Ser. No. 2 (1917)), based on physical-chemical equilibrium relations which leads to the following classification of the salt lake systems: (1) Carbonate (soda) lakes, with a high carbonate ratio ($Na_2CO_3 \neq NaHCO_3$): ($Na_2CO_3 \neq NaHCO_3 \neq NaSO_4 \neq NaCl$) and a high salt concentration and sedimentation of salts (group of the soda lakes of Mikhailovsk). Highly "metamorphic" lakes of this type are characterized by a low Na content and a low carbonate ratio. The inflow is of carbonate ground waters, the chemical conditions of which are determined by the weathering and biochemical factors in the mother soils and rocks of the steppe area. (2) Sulfate and sulfate-chloride lakes in the central parts of the Kulunda depression have a high concentration of the brines and a high "metamorphism coefficient" given by the ratio $MgSO_4:MgCl_2$ (e.g. in some lakes varying between 0.15 and 1.20) and a high concentration in $CaCl_2$. The carbonate coefficient is low in the Kulunda Lake (0.13). Lakes of 2 are deprived from any fluviatile inflows and show a particularly high "metamorphism" of sulfate to sulfate-chloride and even to chloride waters, with a metamorphism coefficient of 0.19 to 4.2. The ground waters feeding the lakes of 2 are derived from sediments rich in gypsum and $MgSO_4$. The geologic history of the salt lakes is characterized by the formation of their basins as synclines of the old hydrographic system of the Kulunda Steppe which, in the late Quaternary period, did not have any connection with seawater basins and deposited the dissolved salts from the accumulated waters. W. Eitel. (Chem. Abst. 49, 1955, 15675)

Nixon, E. K., 1950, Salt in Kansas: Min. Cong. Jour., v. 36, no. 8, p. 65-69.

Deals primarily with mining and processing methods, but includes discussion of the occurrence, stratigraphic relations, and depositional environment of the Kansas salt deposits, which occur in two zones in the Permian strata of the west and central part of the state and consist of interbedded halite and shale. (Ann. Bibl. Econ. Geol., v. 25 for 1952, no. 2, 87)

Norman, G. W. H. See Miller, A. H., 1938.

Parker, R. H., 1955, Changes in the invertebrate fauna, apparently attributable to salinity changes, in the bays of central Texas: Jour. Paleontology, v. 29, p. 193-211.

Previous studies on the invertebrate fauna of the bays of central Texas have been undertaken during periods of very low or highly variable salinity conditions. From 1948 to 1953 an extended drought with accompanying low river runoff caused salinities in these bays to increase to record highs, with little variation between maximum and minimum salinities during any particular month. Coincident with this extended high salinity period, the biotic communities within the bays changed considerably. Not only was there an invasion of many marine or open-Gulf species of invertebrates, but also a change was observed in the growth and appearance of the oyster reefs, one of the principal biotic assemblages. Another probable result of increased salinities was the disappearance of low-salinity mollusks which previous workers had found to be extremely abundant during the periods of low salinity.

This extended series of hydrographic observations should be useful to the paleoecologist in interpreting environmental changes in mega-fossil assemblages. Observations of this nature should prove useful in interpreting sedimentary facies, since many of the species involved occur as fossils at least as far back as the Pliocene. If normal euryhaline fossil assemblages suddenly produce large numbers of high-salinity organisms such as sea urchins, corals, and open-Gulf mollusks, one could assume that there had been drought conditions, with extended high salinities. These conditions can also be recognized by abrupt changes in shell structures of the common oyster, Crassotrea virginica (Gmelin), as well as the absence of known low-salinity mollusks. (Author's abstract)

Peru, Direccion de Petroleo, 1954, El petroleo en el Peru, sus ocurrencias, manifestaciones superficiales y los depositos de sal gema (Petroleum in Peru, its occurrences, surface indications and deposits of rock salt): Peru, Ministerio de Fomento y Obras Publicas, Direccion de Petroleo, Fasc. 1, p. 1-64. (Spanish text)

Compilation of data on and catalog of occurrences of petroleum and rock salt in Peru.

Pflucker, L. A., 1921, La sal en el Peru (Salt in Peru): Peru, Cuerpo Ing. Minas, Anales del Cong. Nac. Industria Minera, tomo 5, p. 97-148. (Spanish text)

Discussion of salt deposits of Peru giving classification, types, geology, description, production, resources, and history of the salt industry.

Phillips, F. C., 1947, Oceanic salt deposits: Chem. Soc. London, Quart. Rev., v. 1, p. 91-111.

A review of the literature covering the order of deposition and the relation of the various salts resulting from the evaporation of seawater. W.B.L.

Portaro, Edgardo, 1935, Informe sobre los yacimientos de salitre de Siguas de la Provincia de Camana (Report on the nitrate deposits of Siguas in the province of Camana): Peru, Cuerpo Ing. Minas, Bol. 113, 136 pp. (Spanish text)

Sampling of nitrate deposits between the Siguas and Majes Rivers, Department of Arequipa. Caliche deposits are widely scattered. All such deposits are on the gentle slopes of hills and streamways, near the surface of the ground, and generally contain more sodium chloride than nitrate. Two commercially promising areas were found, having an area (sic) of 414,255 cubic meters, with an average content of 10 percent sodium nitrate, equivalent to 70,000 tons, allowing for losses in mining and treatment. Cost data are given. C.P.R. (Ann. Bibl. Econ. Geol., v. 19, 1936, 301)

________, 1936, Informe sobre la exploracion de los yacimientos de salitre de la region del oeste del Valle de Majes (Report on the exploration of the nitrate deposits of the region to the west of Majes Valley): Peru, Cuerpo Ing. Minas, Bol. 113A (Appendix to Bol. 113), 20 pp. (Spanish text)

Summarizes the results of sampling and study of nitrate deposits in the region west of the Majes River, Department of Arequipa, and concludes that all deposits here are either too low grade or too small and difficultly accessible for profitable development. C.P.R. (Ann. Bibl. Econ. Geol., v. 19, 1936, 301)

Posokhov, E. V., 1954, O protsessakh nakopleniya solei v mineralnykh ozerakh Kazakhstana (The processes of salt accumulation in the mineral lakes of Kazakhstan): Akad. Nauk S.S.S.R., Gidrokhim. Inst., Gidrokhim. Materialy, tom 22, p. 75-78. (Russian text)

Posokhov summarizes his conclusions on the character of present-day processes of salt accumulation in the Kazakhstan lakes. The sources of salt in the lakes are not associated with ancient types of salt accumulations. In the arid regions, like those of Kazakhstan, 5 types of salt movement can be traced feeding the lakes and causing certain types of salt accumulation. (1) River water type, whereby the salts brought in contain appreciable quantities of sulfates. The composition of these waters does not change from year to year or even over long periods of time and they give rise to lakes of a high sulfate content. (2) Salt accumulation of the type of huge water basins like the Caspian and Aral seas, Balkhash Lake where the composition of salts falls on the equilibrium diagram of crystallization of mirabilite and similar sulfate minerals. (3) Salt accumulation from underground water sources. These waters supply salts which have undergone changes in their path to their respective aquifers, losing all or the bulk of their sulfates. Thus, the lakes contain chloride salts, chiefly of Na and Ca. (4) Salt accumulation from soil ground water. This type contains the chloride-sulfate salts and some Na_2CO_3. (5) Runoff type, which carry the salts of the parent material. These are lakes which get their salts from more than one of the types enumerated. Posokhov concludes that most lakes may trace their salts to recent times, in terms of a few hundred years, or even a few decades. He cites examples of the latter.

J.S. Joffe (Chem. Abst. 49, 1955, 14604)

Posnjak, Eugen, 1940, Deposition of calcium sulfate from sea water: Am. Jour. Sci., v. 238, p. 559-568.

Stability relations of gypsum and anhydrite in solutions of sea salts are of considerable geological interest as many deposits of these minerals are generally considered to be of marine origin. Since it has been shown that the transition point, gypsum-anhydrite, is not governed by a dissociation pressure relationship, but by a four-phase equilibrium, only relative solubilities establish their stability either alone or in presence of other salts. The present determinations in solutions of sea salts were made at 30°. The solubility of gypsum as well as that of anhydrite first increases rapidly in the presence of increasing amounts of sea salts, goes through a maximum at about twice the usual salinity of sea water, and then gradually decreases. However, the decrease is more rapid for anhydrite and an intersection of the two curves takes place at approximately 4.8 times the usual salinity, the point at which anhydrite becomes the stable phase.

Sea water is unsaturated with respect to calcium sulfate, and only after its salt content has increased by evaporation to 3.35 times the usual salinity can deposition take place. Between this concentration and the one required for stable deposition of anhydrite nearly one-half of the total amount of calcium sulphate present in sea water will be deposited at 30° in the form of gypsum. Since at a somewhat lower temperature at which evaporation of a marine basin may be assumed to have taken place the conditions in all probability will not be greatly modified, a large portion of calcium sulphate may always be expected to be deposited as gypsum. Sedimentary marine deposits of pure anhydrite must therefore either be at least partly derived from originally deposited gypsum, or have been formed close to or above 42°---the transition point of the two minerals. (Author's abstract)

Prag, R. See Gentner, W., 1953.

Prikhid'ko, P. L., 1951 Nekotorye dannye ov issledovanii karnallitov (Certain data on carnallite investigations): Akad. Nauk Uzbekskoi S.S.S.R., Tashkent, Vses. mineralog. obshchestvo, Uzbekstanskoye otdeleniye, Zapiski, vypusk 2, p. 90-93. (Russian text)

The content of bromine in carnallite from sea deposits varies from 0.24% to 0.6%. Solikamsk and central Asiatic deposits of this mineral have 0.175-0.215% and 0.0864% Br, respectively. It is suggested that the decrease in Br content of the above deposits was caused by a redeposition of the carnallite during later geologic periods. A. P. Kotloby (Chem. Abst. 49, 1955, 6047)

Quarles, Miller, Jr., 1953, Salt-ridge hypothesis on origin of Texas Gulf Coast type of faulting: Am. Assoc. Petroleum Geologists, v. 37, p. 489-508.

The salt-ridge hypothesis explains the origin of a type of normal faulting found abundantly in the salt-dome province of thick Tertiary sediments bordering the Gulf Coast of Texas. This hypothesis states that deep-seated vertical intrusions of salt in the form of long narrow ridges push up the gulfward dipping beds along their strike to form deep-seated anticlines. A pattern of normal faults with dips of approximately 45° has to develop on every anticline as an adjustment for the vertical forces involved. Depressions or "edge synclines" may parallel the ridges on one or both sides as a result of salt removal.

Two main hypotheses of origin which have previously received the greatest consideration among geologists are: (1) subsidence of the basement rock toward the Gulf, and (2) slipping of sediments downdip toward the Gulf on a bedding plane. Neither the "subsiding-basement" nor the "slipping-plane" hypothesis is found to be adequately in agreement with present evidence.

The salt-ridge hypothesis is the only one of the three hypotheses considered that satisfactorily explains all of the following nine Gulf Coast fault characteristics that are shown on seismograph sections: (1) approximately 45° angles of fault-plane dip, (2) both up-to-the-coast and down-to-the-coast major movement along the same fault trend, (3) adjustment faults forming narrow grabens, (4) dipping down of beds into the downthrown side of faults, (5) dipping up of beds under the upthrown side, (6) great increase of throw with depth, (7) abrupt dying-out of faults laterally, (8) localized throw across fault with no relative displacement of beds a mile or more away, and (9) a decrease with depth in the amount of formational dip down into the downthrown side of the fault. The presence of salt ridges would require that new concepts by used for locating deep oil fields. Favorable structures would be far more numerous than are now envisioned and the location of test wells with respect to the basic salt anticline would be relatively simple. (Author's abstract)

Quiring, Heinrich, 1954, Permklima und Sonnentemperatur (Permian climate and the temperature of the sun): Neues Jahrb. Geologie u. Paläontologie Monatsh., Jahrg. 1954, Heft 7, p. 322-328. (German text)

The temperature of formation of the K and Mg minerals precipitated in the upper Permian remnant seas of central and western Germany is 70°-110° C. Such temperature can be explained only by greater effective radiation from the sun at that time, here calculated to have been about 430° C. higher than at present. The mean surface temperature of the earth must then have been 23.1° C.

Ramage, Hugh. See Hartley, W. N., 1897.

Raman, C. V. and Ramdas, A. K., 1954, On the polycrystalline forms of gypsum and their optical behavior: Indian Acad. Sci. Proc., v. 39, sec. A, p. 153-161; Raman Research Inst. Mem. 48.

A naturally occurring form of gypsum is not fibrous but consists of fine rods oriented nearly parallel to the b-axis and is readily cleaved along planes perpendicular to that axis. A source of light viewed through a 1-mm. plate of the material shows 3 concentric circles of light that are characteristically polarized, and that arise from internal reflections at the rod boundaries. The name fascicular gypsum is suggested. Some observations on the optical behavior of alabaster and satin spar are included. P. E. Braid (Chem. Abst. 48, 1954, 13558)

Ramdas, A. K. See Raman, C. V., 1954.

Rawson, D. S., and Moore, J. E., 1944, The saline lakes of Saskatchewan: Canadian Jour. Research, Sec. D, Zool. Sciences, v. 22, p. 141-201.

Sixty lakes in central and southern Saskatchewan were investigated during the years 1938 to 1943. Most of these are saline and lie within the aspen parkland. A few freshwater lakes from the adjacent forest zone were included for comparison. Most of the lakes have between 300 and 30,000 p.p.m. of total solids; Little Manitou Lake has 120,000 p.p.m. The salts are mostly sulfates of Mg or Na with little chlorides. Seasonal, annual, and long-term variations in salinity are discussed. Plant and animal populations of the lakes are described. The lakes are classified as saline eutrophic. Salinity is the dominant influence and it is also an expression of the climatic and physiographic factors that were responsible for the formation of the lakes. The saline lakes of Saskatchewan are much like those in the steppes of western Siberia. E. H. (Chem. Abst. 39, 1945, 2237)

Rich, J. L., 1941, The nitrate district of Tarapaca, Chile; an aerial traverse: Geog. Rev., v. 31, p. 1-22.

_____, 1942, Physiographic setting of the nitrate deposits of Tarapaca, Chile; its bearing on the problem of origin and concentration: Econ. Geology, v. 37, p. 188-214. (Discussed later by J. T. Singewald, Jr., same journal, v. 37, p. 627-639.); (abs.) Geol. Soc. America Bull., v. 51, 1940, p. 1941.

Aerial photographs of the nitrate region of Tarapaca, Chile, reveal features of the topographic setting of the deposits which bear significantly on the problems of their origin. Nitrate accumulations prevail on the lower slopes of the old-age Coast Range bordering the west side of an alluvium-filled depression between that range and the Andes, but the deposits seem to rise too high up the slopes to have been derived from the waters of the alluvial flats. Analysis of various theories of origin points to a derivation by weathering and concentration from the predominating lavas and tuffs of the bed rock. This hypothesis seems to harmonize best with the various facts of occurrence, among which the topographic setting is one of the most significant. (Author's abstract)

Ricour, Jean. See Bourcart, Jacques, 1954.

Roeber, Joachim, 1938, Die Jodverteilung in den deutschen Salzlagerstätten. Gründe für Auftreten und Fehlen von Jod in verschiedenen Horizonten des Zechsteins und in Erdölwässern. (The distribution of iodine in the German salt deposits. Reasons for the occurrence and absence of iodine in different horizons of the Zechstein and in oil-well waters): Kali, v. 32, p. 209-211, 221-223, 233-236. (German text)

Kieserite and anhydrite highest in iodine. (Chem. Abst. 33, 1939, 1634)

Romanes, James, 1931, Salt domes of northern Germany: Inst. Petroleum Technologists Jour., v. 17, p. 252-258.

The author concludes that (1) salt domes are derived from normal sedimentary deposits of salt, (2) although the salt of Germany is late Permian in age, salt of any other period would produce domes under similar conditions, (3) although folding may initiate and determine orientation of domes, it is loading that renders the salt plastic, (4) it is indicated that some 2,000 meters of overburden is required to initiate true doming and that penetration is more likely under heavy overburden than arching of the beds, (5) salt domes are related to oil only in that they provide reservoirs for accumulation. W.B.L.

Rozen, B. Ya., 1953, O nakoplenii i raspredelenii ioda i broma v solyanykh ozerakh i neftyanykh (burovykh) vodakh (Accumulation and distribution of iodine and bromine in salt water lakes and petroleum drill holes): Ukrainskii Khimichnii Zhurnal 19, p. 679-682. (Russian text) (Russian title taken from: Referat. Zhur., Khim. 1954, no. 13, 32273)

The Br content in the brine of various mineral lakes is 0.24-1.5 g./l. which means that it greatly exceeds the Br content of sea water. It is noteworthy that the concentration of Br in brine increases with the content of Mg and K. An analogous situation is observed in petroleum water for Br and I. During the process of natural vaporization or artificial concentration of brine the Br in the liquid phase first increases proportionately to the concentration of salts; however, from the moment NaCl starts crystallizing the rate of Br accumulation increases. Iodine does not accumulate in lake brine except in lakes genetically connected with oil-bearing regions. Thus, the brine of the lake Beyuk-Shor in the Baku region contains 0.0015-0.0019% I. From lake brine I disappears, apparently as a result of oxidation of iodides to free I by the O in the air and a much higher adsorption of I by silt as compared with the adsorption of Br. M. Hoseh (Chem. Abst. 49, 1955, 6669)

Ruiz, A. Hoyos. See Cavaye Hazen, E., 1953.

Sansores, Enrique. See Contreras V., Hugo, 1953.

Schmidt, Carl, 1931, The salt dome area west of Celle, Germany: Inst. Petroleum Technologists Jour., v. 17, p. 372-375.

Investigations by seismic and gravimetric methods disclosed that only one large salt dome existed at the intersection of the Hercynian and Rhenish folds. Folding is suggested as the cause for localizing most domes in the north German area. W.B.L.

Schroeder, J. W., 1946, Geologie de l'île de Larak; contribution à l'étude des domes de sel du golfe Persique; comparaison avec la Salt Range (Geology of the island of Larak; contribution to the study of salt domes of the Persian Gulf; comparison with the Salt Range): Arch. Sci. phys. et nat., v. 28, p. 1-18. (French text)

Larak island in the Hormuz strait of the Persian gulf is composed essentially of a salt dome with which lower Paleozoic rocks are associated, surrounded by Tertiary sedimentary formations. Emplacement of the salt dome took place over a long period of time between the upper Cretaceous and Quaternary and was caused by a combination of tangentially orogenic forces and the difference in density between the salt and the Tertiary beds. The lower Paleozoic formations exhibit striking lithological affinities with the salt-bearing series of the Salt Range, India, for which a Cambrian age seems more probable than the Eocene age proposed by some. (G.S.A. Bibl., v. 17, 1952, 385)

Schultz, A. R., 1910, Deposits of sodium salts in Wyoming: U.S. Geol. Survey Bull. 430-I, p. 570-589.

"Wyoming is noted for its salt, sulphur, iron alkaline earth, mud, and hot springs, which are scattered all over the State. In addition to the deposits formed from these mineral springs there occur in Wyoming extensive deposits of soluble salts of sodium and magnesium--for the most part in small drainage areas or basins which have no outlet. Many of these depressions are locally called 'lakes,' as they form the lowest parts of the basins and during the spring and early summer months are covered with shallow waters. During wet seasons some of these 'lakes' contain water throughout the year. A few of the soda lakes, as the Wilkesbarre and Wilmington lakes, never become dry and form no solid deposits, the soda being entirely in solution. The soda basins or 'alkali lakes' are more or less irregular and the deposit of salt in the different parts of the basin of varying thickness. The salt beds are usually very thin along the edge of the basin and thicken towards the center. In some localities these alkali deposits have been utilized, but for the most part no effort has been made to develop them for commercial purposes. A few of the mineral springs in Wyoming have been developed for their medicinal value and have attained considerable commercial success.

"In the Yellowstone Valley salt springs are numerous, but thus far no effort has been made to utilize the brine in the manufacture of salt. Extensive beds of salt of great purity occur in Crook County west of the Black Hills and in western Uinta County along the Salt River Mountains. Salt springs and deposits are known to be present in Bannock County, Idaho, and western Uinta County, Wyo., along the state line. In both of these localities salt has been produced for many years. The salt producing area in Uinta County, Wyo., lies south of Star Valley, on the route from Smoot, in upper Star Valley, to Thomas Fork. The salt developments are located on Salt Creek, in the SW. $\frac{1}{4}$ sec. 26, T. 29 N., R. 119 W., about 8 miles northeast of Green's ranch or the head of Thomas Fork. The brine springs in this part of Wyoming are similar to the workable springs along the Idaho-Wyoming border described by C. L. Breger in the preceding paper in this bulletin. It is highly probable that in this vicinity rock salt will be found beneath the surface similar to the rock-salt deposits discovered in 1902 on lower Crow Creek, a tributary to Salt River in eastern Idaho.

"No attempt will be made in this paper to describe all the various salt deposits, mineral springs, and alkali flats in Wyoming or to give their distribution. A few of the largest and most important soda deposits and lakes will be briefly described, and a short discussion of the sodium-carbonate developments at Green River will be presented." (Author's introduction)

Scruton, P. C., 1953, Deposition of evaporites: Am. Assoc. Petroleum Geologists Bull., v. 37, p. 2498-2512.

Modern oceanographic studies in estuaries and other restricted arms of the sea have shown that a characteristic circulation pattern exists. Surface currents flow from regions of low salinity to regions of higher salinity in response to hydrostatic head and are accompanied at depth by oppositely directed currents flowing from high to low salinity regions because of density distribution. Salts are deposited in restricted estuaries where evaporation exceeds precipitation plus runoff. The necessary restrictions of the estuary or basin are in part dynamic, and in part static. Dynamic restriction is caused by the hydrostatic head and by frictional stresses between the oppositely directed surface and bottom currents, and between the bottom current and the channel floor. Static restriction is produced by topographic confinement.

When high concentrations are developed, a strong horizontal salinity gradient exists which produces lateral segregation of different salts during precipitation. The escaping deep current returns to the sea those salts which have not been precipitated. Fluctuations in equilibrium caused principally by changes in excess of evaporation or in degree of channel closure cause migrations of the horizontal salinity gradient along the longitudinal axis of the basin which produce vertical differentiation of salts. The order in which salts occur in the vertical column can be predicted from oceanographic and chemical data and agrees well with many vertical sequences which have been described. (Author's abstract)

Secretary of the Interior, 1955, Saline water conversion: U.S. Dept. of the Interior, 3d Ann. Rept., 125 p.

This is a report covering the present status of various investigational programs in search of a means for economically removing salts from sea or brackish water. The objective is to make fresh water available for domestic or irrigation use, in which salt is the waste material and not the desired product.

Shchepetunin, I. F., 1937, Brom v solyanoi tolshche Irkutskogo solenosnogo basseina i otkhodakh solevarennogo zavoda (Bromine in the salt beds of the Irkutsk salt-bearing basin and in the waste waters of the salt plant): Problemy Sovetskaya Geologiya, tom 7, p. 726-729. (Russian text)

Br contents given are: Irkutsk salt brines, 69-91 g. per cu. m.; mother liquors, 945 g./cu.m.; crystallized salt, 0.03%; deep-bore salt brines 1.25 kg./cu.m.; crude salt 0.04-0.05%; carnallites, 0.40-0.46%. This is a valuable source for Soviet bromine. (Chem. Abst. 32, 1938, 461)

Shouldice, J. R., 1955, Silurian reefs of southwestern Ontario: Canadian Min. Met. Bull., v. 48, no. 520, p. 500-503.

These pinnacle reefs are not associated with atoll-like structures, but they are of limited areal extent. This paper refers only to the Middle Silurian Guelph-Lockport formations of Niagaran age and the Upper Silurian Salina formation. The Guelph-Lockport is largely composed of crystalline dolomite and the Salina is largely evaporites, including salt, shale, anhydrite, and dolomite. Nine pinnacle reefs are mainly dolomite, 2 are mainly limestone, 6 are dolomite and limestone, and the compositions of 8 are unknown. One reef contains oil, 16 contain gas, 2 contain H_2O, and 6 are nonporous. C.W. Schuck (Chem. Abst. 49, 1955, 13847)

Singewald, J. T., Jr., 1943, Bibliography of Economic Geology of South America: Geol. Soc. America Special Paper 50, 159 p.

This bibliography contains some references to salt deposits in South America, particularly, in Argentina, Chile, and Peru.

________, 1942, Origin of Chilean nitrate deposits: Econ. Geology, v. 37, p. 627-639. (Discussion of paper by J. L. Rich, same journal, v. 37, p. 188-214.)

Lack of detailed geologic descriptions greatly hamper attempts to arrive at logical conclusions as to origin. Many facts on occurrence of nitrate beds, their relation to sulfate-and-chloride-bearing formations, and to bed rock of the area, are presented and conflicts and agreements of various theories of origin with these facts are reviewed. The theory of Singewald and Miller propounded in 1916 that the nitrates originated from evaporating ground waters has its strong points and its weaknesses; likewise the Whitehead theory that volcanic rocks furnish the source of nitrates has some arguments in its favor, while other circumstances tend to discredit it.
O. B. (Ann. Bibl. Econ. Geol., v. 15, 1942, 208)

Sloss, L. L., 1953, The significance of evaporites: Jour. Sedimentary Petrology, v. 23, no. 3, pp. 143-161.

Environments of basins. Current flow pictures do not seem to incorporate recent oceanographic concepts.

Smits, F. See Gentner, W., 1953.

Stewart, F. H., 1953, Early gypsum in the Permian evaporites of northeastern England: Geologists' Assoc. (London), Proc., v. 64, p. 33-39.

Structures visible on weathered core surfaces are interpreted as anhydrite-halite pseudomorphs after rosettes of gypsum crystals. The conditions of formation and subsequent alteration to anhydrite are discussed. Michael Fleischer (Chem. Abst. 47, 1953, 6312)

__________, 1954, Permian evaporites and associated rocks in Texas and New Mexico compared with those of northern England: Yorkshire Geol. Soc. Proc., v. 29, p. 185-235.

A review and comparison of the geologic setting, conditions of formation, and mineralogy. The English deposits contain more quartz and clay and less $MgSO_4$; langbeinite is nearly absent. Rinneite has not been found in the U.S. deposits, but is common in the English. In both deposits, recrystallization and replacement have greatly affected the mineralogical composition. 85 references. Michael Fleischer (Chem. Abst. 49, 1955, 800)

Stewart, J. S. See Lord, C. S., 1947.

Strakhov, N. M., and Zalmanson, E. S., 1944, On the content and forms of organic matter in the sediments of the lower Permian saline lagoon of the Near-Ural area of Bashkiria: Acad. sci. U.R.S.S. Comptes rendus (Doklady), v. 45, p. 338-341. (English text)

The chemogenic facies of the saline lower Permian lagoon of the Near-Ural area of the Bashkiria contain very little organic matter. Thus the anhydrite rocks contain only traces of organic matter (none to 0.03-0.05% C) while carbonate facies contain only up to 0.6% C as organic matter. The presence, in dark or gray sedimentation rocks, of larger amounts of organic matter (up to 1.6% C) and its much lower concentration in corresponding red rocks indicates that organic matter was brought into the lagoon by streams from the Uralian dry land. The organic matter entering the lagoon tended to be carbonized rather than converted to bitumen. Hence, although gray terrigenous facies concentrated organic matter, they probably were not responsible for formation of the Kungurian oil which sometimes occurs in Bashkiria. J. W. Perry (Chem. Abst. 39, 1945, 4820)

Swineford, Ada, McNeal, J. D., and Crumpton, C. F., 1954, Hydrated halloysite in Blue Hill shale, <u>in</u> Clays and clay minerals, Proc. 2nd Natl. Conf. 1953: Natl. Acad. Sci.-Natl. Research Council Pub. 327, p. 158-170.

Nodules of alunite and hydrated halloysite have formed at the contact of septarian concretions with the shale and are associated with gypsum. Chemical analyses are given. Edward D. Goldberg (Chem. Abst. 49, 1955, 15654)

Teodorovich, G. I., 1949, Sideritovaya geokhimicheskaya fatziya moreyi i voobshche solenykh vod kak nefteproizvodyashchaya (Siderite geochemical facies of seas and saline waters in general as oil-producing): Akad. Nauk S.S.S.R. Doklady, Novaya seriya, tom 69, p. 227-230. (Russian text); English translation by G. V. Chilingar in: Am. Assoc. Petroleum Geologists Bull., v. 39, 1955, p. 762-764.

A siderite facies commonly characterizes near-shore, shallow-water marine deposits which are favorable hosts for organic matter that ultimately may be transformed into petroleum bitumens. Examples of oil-bearing formations characterized by a siderite facies are described from several localities in the Soviet Union. (G. S. A. Bibl., v. 20, 1955, 532)

Thode, H. G., Wanless, R. K., and Wallouch, R., 1954, The origin of native sulphur deposits from isotope fractionation studies: Geochimica et Cosmochimica Acta, v. 5, no. 6, p. 286-298.

Sulphur and carbon isotope abundance studies have been made on the sulphur well cores and adjacent formations of the Texas and Louisiana salt domes. The free sulphur was found to be depleted in S^{34} with respect to associated sulphate by 3.9 percent on the average. This compares to a 3.2 percent fractionation of the sulphur isotopes by bacterial action in North African lakes. Also, the associated sulphate was found to be enriched in S^{34} as compared to adjacent anhydrite formations to various extents depending on the sulphur well investigated.

Carbon isotope ratios obtained for the calcite matrix of the sulphur well cores showed that the carbon of the calcite was depleted by from 3.3 to 5.5 percent in C^{13} as compared to standard limestone. These results indicate that the calcite was formed simultaneously with the free sulphur from carbon of organic origin by a process resulting in some further fractionation of the carbon isotopes.

All the isotope abundance data can be reconciled with the conclusion that the large sulphur deposits of the southwestern United States have been formed by living organisms. (Authors' abstract)

Thompson, T. G., and Nelson, K. H., 1956, Concentration of brines and deposition of salts from sea water under frigid conditions: Am. Jour. Sci.,v. 254, p. 227-238. (Discussion by G. W. Bain, same journal, p. 758-760)

The purpose of this paper is to present evidence that the origin of some salt deposits may have occurred from the concentration of sea water under frigid conditions rather than by evaporation. The order in which the salts deposit from brines subjected to such conditions differs from the order in which salts deposit by evaporation. Concentrated brines result from the freezing of sea water from which small quantities of calcium carbonate precipitate. On cooling, sodium sulfate decahydrate is deposited from the brines, followed by the depositions of the sodium chloride dihydrate, potassium chloride, and magnesium chloride. Carnallite can form only as the result of secondary reactions. The embayment and bar theory of Bischof and Ochsenius is applied to explain the deposition of salts by frigid concentration from sea water and also to explain the formation of some sulfate lakes. (Authors' abstract)

Tomic, Ernst. See Koczy, F. F., 1957.

Trembecki, Adam, 1955, Porównanie jakości gipsow nadnidziańskich z gipsami przykarpackimi (Comparison of Carpathian gypsum and deposits of gypsum in Nida Valley): Cement Wapno Gips (Czerwiec), rok 11/20, nr. 6, p. 123-128. (Polish text)

Characteristics of the following gypsum deposits are given. Deposits in the region of Wiślica-Kobylniki and in the region of Krzyzanowice-Gacki, both of the Nida Valley, contain an average 91.10 and 92.12% $CaSO_4.2H_2O$, respectively; the deviation in gypsum composition is ± 2.95 and ± 2.62% respectively. The deposits contain the following morphological forms: shale gypsum containing 87.32, gypsum of large and medium crystals containing 91.70, and gypsum of long crystals containing 95.34% of $CaSO_4.2H_2O$. Deposits in Dzierzyslaw and in Lopuszka Wielka are located in the western and eastern sub-Carpathian regions, respectively. The former contains an average of 90.37 and the latter contains an average of 94.60% $CaSO_4.2H_2O$. The former deposit is composed of large crystals and the latter of alabaster gypsum which contains 99.50% $CaSO_4.2H_2O$. F. J. Hendel (Chem. Abst. 49, 1955, 13038)

Trevisan, Livio, 1952, Sul complesso sedimentario del miocene superiore e pliocene della val di Cecina e sui movimenti tettonica tardivi in rapporto ai giacimenti di lignite e di salgemma: (On the upper Miocene and Pliocene sedimentary complex of the Cecina valley and its late tectonic movements in relation to lignite and rock salt deposits): Soc. Geol. Italiana, Boll., v. 70 for 1951, p. 65-78 (Italian text; French summary); Italy, Consiglio Naz. Ricerche, Centro Studi Geol. Appennino, Pub., fasc. 3, no. 12.

On the basis of field observations in the late Tertiary terrain of the Cecina valley, central Italy, outlines the paleogeographic conditions of upper Miocene and Pliocene sedimentation in western Tuscany, with special reference to lacustrine basins produced by recurrent faulting in which the salt and lignite deposits of the valley were formed. G. S. (G.S.A. Bibl., v. 20, 1955, 547)

Valvano, J. See Angelelli, V., 1946.

Valyashko, M. G. See Bergman. A. G., 1953.

Van Waterschoot van der Gracht, W. A. J. M., 1926, The structure of the salt domes of northwest Europe as revealed in salt mines, <u>in</u> Geology of salt dome oil fields: Am. Assoc. Petroleum Geologists, p. 45-49.

The mechanics of the process and mode of formation of salt domes is briefly and simply outlined. The explanation for their structure and composition is derived from early investigations made of the north German Permian salt deposits and the Roumanian diapiric anticlines. W.B.L.

Vila, Tomas, 1937, El borato en Chile. Estudio sobre la situacion actuel de la industria boratera y sus perspectivas (Borate in Chile. Study of the present condition of the borate industry and its prospects): Bol. Minas y Petroleo (Santiago, Chile), v. 7, no. 67, p. 45-93. (Spanish text)

A study of the borax production of the world and particularly in Chile. The latter country possesses large reserves of borax marshes, the most common mineral being boronatrocalcite (ulexite). Only two concerns manufacture borax products. Annual production about 100 tons of borax and 70 tons of boric acid both consumed locally. Visible reserves estimated at 30 million tons of crude material. Borax Con. Ltd. controls the best deposits. It closed its operations in Chile in 1929, and, it is said, is not likely to begin them again. The various reasons for this are fully discussed. One of them is, of course, the great deposits of rich rasorite (kernite) discovered in California. The only remedy would be for Chile to declare the borax deposits property of the State and offer their lease and exploitation to the highest bidder. W. L. (Ann. Bibl. Econ. Geol., v. 10, 1937, 66)

Vorob'ev, A. L., and Kadysev, E. N., 1951, K mineralogii solonchaka Shchor-kan (Mineralogy of the Shor-kan salt marsh /, Central Asia, U.S.S.R./): Akad. Nauk Uzbekskoi S.S.R., Tashkent, Vses. mineralog. obshchestvo, Uzbekistanskoye otdeleniye, Zapiski, vypusk 2, p. 78-80. (Russian text)

The expedition of 1940 found that the salt marsh Shor-kan is rich in mirabilite, glauberite, thenardite, and gypsum. A. P. Kotloby (Chem. Abst. 49, 1955, 6040)

Voronova, M. L., 1954, K vosprosu obnaruzheniya poligalita i kainita v sul'fatnoi solenosnoi tolshche Uzun-Su (Discovery of polyhalite and kainite in the sulfate salts of Uzun-Su): Akad. Nauk S.S.S.R. Doklady, Novaya seriya, tom 99, p. 449-450. (Russian text)

Between the metamorphic kainite rock and the massive halite salt, the formation of thenardite and bloedite on the contacts is characteristic. Polyhalite is always highly dispersed in the halite in microgranular form. Some clayey material is interspersed in the salt rocks, but sylvinite has never been observed. This occurrence of polyhalite and kainite is the first indication of the existence of K salts in the Tertiary deposits of oceanic (Kara-Bogaz) type in Central Asia (Turkmen.) Usually the concentration of K for the waters of the sulfate lakes is only 0.01 to 0.10%, but in the natural brines of Uzun-Su the K is increased to 0.25%. The kainite is superficially changed to epsomite and picromerite; glauberite also occurs in subordinate amounts. Probably the kainite crystallized as a primary mineral. W. Eitel (Chem. Abst. 49, 1955, 7453)

Wade, Arthur, 1931, Intrusive salt bodies in coastal Asir, south western Arabia: Inst. Petroleum Technologists Jour., v. 17, p. 321-330.

A description of islands of Farisan and the Asir coast of southwest Arabia in which salt domes and outcrops have been found. There is doubt as to the age of the salt, but it is believed to be Triassic. W.B.L.

Wallouch, R. See Thode, H. G., 1954.

Wanless, R. K. See Thode, H. G., 1954.

Waterschoot van der Gracht, W. A. J. M. van. See Van Waterschoot van der Gracht, W. A. J. M.

Weaver, Paul, 1946, The formation of evaporites under marine evaporation conditions (abs.): Am. Assoc. Petroleum Geologists Bull., v. 30, no. 11, p. 1965-1966.

Sediments consisting principally of salt, anhydrite and gypsum, potash, and certain types of limestone and dolomite have a wide areal extent in certain stratigraphic units and are as of persistent a character as many other sedimentary deposits. Depositions of these beds occurred in large bodies of water in an environment where evaporation exceeded precipitation and where the temperature and other climatic factors were so controlling that they impressed upon the beds special traits which have continued through subsequent geologic time, and a study of these depositions, therefore, enables us to deduce the paleogeography and paleo-climate by applying physical and chemical tests to the sediments.

The primary purpose of this paper, therefore, is to show the combined use of physics, chemistry, and geology in the understanding of a particular environment, and to stimulate the geologist to the utilization of other scientific data to the better understanding of sedimentary processes. The paper begins with a discussion of the warming of a body of water by solar energy, and the change in evaporation with increase in salinity up to the point where water has been saturated as to one or more compounds, and then the order in which precipitation takes place as to different minerals. Actual sediments containing these precipitates are then discussed in order to show the time involved in their formation and the physiography and climate of the basin in which they were formed. The changes which take place in these sediments after burial and particularly the ones immediately following deposition, are discussed.

The paper does not go into any detailed sections in any particular salt series, except what may be necessary to demonstrate some particular points, but from the general principles of this type of sedimentation it is believed that geologists, working in areas where there are sediments of this kind, will understand better the particular areas where they are making correlations by subdividing the sediments of this class. (Author's abstract)

______, 1952, Application of geophysical technique to finding more flank production on piercement-type salt domes: Oil and Gas Jour., v. 51, no. 7, p. 90, 92, 94.

Discusses use of geophysical exploration techniques in finding oil on piercement-type salt domes, with special reference to the work done in Louisiana, Mississippi, and Texas. Some information on geology and structure included.

Wetzel, W., 1928, Die Salzbildungen der chilenischen Wüste (Salt formations of the Chilean desert): Chemie der Erde, Band 3, p. 375-436. (German text)

This is a detailed paper but based only on German and Spanish references, and the writer's visit to Toco province in the middle part of the desert. Each of the minerals present is described (pp. 385-413).

The salt formation is arranged in zones. The summits of the hills which project out of the desert-wash form one zone, in which the most soluble salt, anhydrite, coats the rock. Considers "arid weathering," in which condensation of moisture from the air collects atmospheric nitrogen. This is washed into the little valleys and the nitrate serves as a cement to the detrital material. The most intense concentration occurs on the east flank of the north-south valley.

The salt glauberite belongs to a more recent period in the desert development, while the nitrate formation began early and continued with increasing intensity. J.L.G. (Ann. Bibl. Econ. Geol., v. 1, 1928, 131)

Whitbeck, R. H., 1931, Chilean nitrate and the nitrogen revolution: Econ. Geography, v. 7, no. 3, p. 273-283.

Describes changes in the Chilean nitrate industry resulting from the great increase in production of synthetic nitrogen. Technical improvements have been introduced by the Guggenheim Brothers and the Nitrogen Corporation of Chile has been formed by the Chilean producers and the Chilean Government. An international cartel was formed in 1930 (for one year) to limit production, allocate markets, and control prices. L. B. (Ann. Bibl. Econ. Geol., v. 4, 1931, 72)

Williams, A. J., 1952, Saskatchewan's industrial minerals: Min. Eng., v. 4, p. 396-400.

Briefly reviews the geology of Saskatchewan. Discusses the occurrences of clay, bentonite, sodium sulphate, magnesium compounds, volcanic ash, silica sand, marl, quartzite pebbles, feldspar, asbestos, limestone, salt, and potash. Contains a map showing the location of wells in which salt and potash have been found. W.B.L.

Wilson, H. W., 1947, An outline of the history and development of the salt industry in Canada: Canadian Inst. Min. Metallurgy Trans., v. 50, p. 527-532.

The history of the early phase of the Canadian salt industry is recounted. Salt was first produced in 1866 in southwestern Ontario and up to 1917 Ontario was the only province producing commercial salt. Now salt is produced in 8 or 9 provinces, Quebec being the only exception. Since solar evaporation is not commercially practical in Canada, the marketed salt in coarse, flake, and fine size is obtained by mining salt beds or by solution and evaporation. W.B.L.

Witkind, I. J., 1952, The localization of sodium sulfate deposits in northeastern Montana and northwestern North Dakota: Am. Jour. Sci., v. 250, p. 667-676.

The sodium sulfate deposits of northeastern Montana and northwestern North Dakota are confined to depressions within the glacial drift. The alignment of the deposits, many of which are linear, suggests some form of glacial control. It is believed that the localization of these deposits is related to buried channels that have been formed marginal to the ice. (Author's abstract, partial)

Wolf, A. G. See Hanna, M. A., 1941.

Woolnough, W. G., 1937, Sedimentation in barred basins and source rocks of oil: Am. Assoc. Petroleum Geologists Bull., v. 21, p. 1101-1157.

Humidity favors development of lacustrine conditions, of coal, boghead and oil shale, while aridity controls formation of black shales, source rocks of oil and ultimately salt deposits. Fineness of texture and lamination, blackness of shale deposits, high organic content, pyritization and composition of oil-field waters are due to barred-basin environment and not to excessive depth of water.

A. H. Emery (Chem. Abst. 32, 1938, 461)

Zalmanson, E. S. See Strakhov, N. M., 1944.

Zdanovskii, A. B., 1953, K gidrokhimii ozera Ebeity (Hydrochemistry of Lake Ebeita): Vsesoyuz. Nauch.-Issledovatel. Inst. Galurgii, Trudy 27, p. 193-204. (Russian text) (Russian title taken from: Referat. Zhur., Khim. 1954, no. 13, 32274)

The sulfate Lake Ebeita in the Omsk region contains in its brine and bottom deposit appreciable quantities of Na_2SO_4 and is used for extraction of mirabilite. The settling out of mirabilite commences in the beginning of fall when the brine cools below 15-20°, and in winter the layer of mirabilite at the bottom of the lake is 6-30 cm. thick. The seasonal variations in the composition of the brine and the effects of the relative changes of the lake level on the mirabilite content were studied. M. Hoseh (Chem. Abst. 49, 1955, 7157)

Zevallos, G. D., 1934, El yeso en Lima (Gypsum in Lima): Peru, Cuerpo Ing. Minas, Bol. 110, 179 pp., 5 figs., 28 pls. (Spanish text)

Gypsum deposits and their exploitation, Lima district, Peru.

Anonymous, 1954, Salt domes in Arctic Circle may be oil field: Min. Rec., v. 65, no. 4, p. 16.

The discovery of salt domes within 800 miles of the North Pole on Ellef Ringnes Island [Canada], may indicate the presence of large and extensive salt beds at depth. W.B.L.

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- Barbour, 1916
- Dole, 1912
- Gale, 1917

New Mexico

- Dunlap, 1951
- Free, 1912
- Lindberg, 1946

New Mexico (cont.)

- Stewart, 1954

North Dakota

- Binyon, 1952
- Witkind, 1952

Northern Ireland

- See Ireland, Northern

Ohio

- Bownocker, 1905

Oklahoma

- Clifton, 1944

Palestine

- Lees, 1931

Persia

- See Iran

Peru

- Haapala, 1953
- Hoempler, 1953
- Peru, Direccion de Petroleo, 1954
- Pflucker, 1921
- Portaro, 1935, 1936
- Singewald, 1943
- Zevallos, 1934

Poland

- Gawel, 1955
- Trembecki, 1955

Production

- Alberta, Dept. Economic Affairs, 1948
- Cameron, 1949
- Flynn, 1951
- Gale, 1917
- Hull, 1952
- Hume, 1947
- Ladoo and Myers, 1951
- Lang, 1957
- Lapidus, 1948
- Nixon, 1950
- Pflucker, 1921
- Portaro, 1935
- Schultz, 1910
- Vila, 1937
- Whitbeck, 1931
- Wilson, 1947
- Zevallos, 1934

Queensland, Australia

- Joplin, Carter, and Burnett, 1954

Reserves

- Nixon, 1950

Resources

- Ahlfeld, 1954
- Barbour, 1916
- Binyon, 1952
- Bownocker, 1905
- Cameron, 1949
- Cole, 1915
- Harrison, 1931
- Hobson, 1945
- Hull, 1952
- Ladoo and Myers, 1951
- Lang, 1957
- Nixon, 1950
- Portaro, 1935
- Vila, 1937
- Wilson, 1947
- Zevallos, 1934

Roumania

- Van Waterschoot van der Gracht, 1926

Russia

- See U.S.S.R.

Salt Domes

- Contreras V. and Sansores, 1953
- Currie, 1956
- Desjardins, 1952
- Dupouy-Camet, 1953
- Escher and Kuenen, 1929
- Hanna and Wolf, 1941
- Harrison, 1930, 1931
- Hoempler, 1953
- Lang, 1957
- Lees, 1931
- Macdonald, 1953
- Melchior, 1953
- Quarles, 1953
- Romanes, 1931
- Schmidt, 1931
- Schroeder, 1946
- Shouldice, 1955
- Thode, Wanless and Wallouch, 1954
- Van Waterschoot van der Gracht, 1926
- Weaver, 1952
- Anonymous, 1954

South America

- Singewald, 1943

South Australia

- Johns, 1952

Spain

- Cavaye Hazen and Hoyos Ruiz, 1953
- Mir Amoros, 1946, 1947
- Mir Amoros and Lopez de Azcona, 1948

Stratigraphy

- Ahlfeld, 1954
- Baar, 1954
- Bancroft, 1938
- Bergman, Valyashko, and Feigel'son, 1953
- Biltz and Marcus, 1909
- Borchert and Baier, 1953
- Bourcart and Ricour, 1954
- Briggs and Lucas, 1954
- Clifton, 1944
- Contreras V. and Sansores, 1953
- Dabell, 1931
- Dunlap, 1951
- Harrison, 1930, 1931
- Hills, 1942
- Hoempler, 1953
- Hume, 1947
- Imlay, 1952
- Landes, 1945
- Lang, 1957

Stratigraphy (cont.)

Lapidus, 1948

Lees, 1931

Lord, 1951

Nixon, 1950

Parker, 1955

Peru, Direccion de Petroleo, 1954

Rich, 1941, 1942

Romanes, 1931

Schroeder, 1946

Scruton, 1953

Shouldice, 1955

Stewart, 1953, 1954

Strakhov and Zalmanson, 1944

Van Waterschoot van der Gracht, 1926

Wetzel, 1928

Witkind, 1952

Structure

Bancroft, 1938

Briggs and Lucas, 1954

Bruggen, 1928

Clements, 1954

Contreras V. and Sansores, 1953

Currie, 1956

Desjardins, 1952

Structure (cont.)

Dupouy-Camet, 1953

Escher and Kuenen, 1929

Harrison, 1930, 1931

Hayes, 1920

Hoempler, 1931

Hume, 1947

Krull, 1953
Landes, 1945
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Miller and Norman, 1938

Pflucker, 1921

Quarles, 1953

Schmidt, 1931

Shouldice, 1955

Singewald, 1942

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Van Waterschoot van der Gracht, 1926

Weaver, 1952

Wetzel, 1928

Witkind, 1952
Anonymous, 1954

Subsurface brines

Alberta, Dept. Economic Affairs, 1948

Assarsson, 1949

Bain, 1956

Subsurface brines (cont.)

Bancroft, 1938

Bergman, Valyashko, and Feigel'son, 1953

Biltz and Marcus, 1909

Bostock, Mulligan, and Douglas, 1957

Briggs and Lucas, 1954

Carl, 1940

Cole, 1915, 1930

Cordini, 1950

Dabell, 1931

Debyser, 1952

Delecourt, 1946

Dellwig, 1955

Eardley, 1938

Feodot'ev, 1949

Gawel, 1955

Hayes, 1920

Koczy, Tomic, and Hecht, 1957

Kovda, Egorov, Morozov, and Lebedev, 1954

Ladoo and Myers, 1951

Lang, 1957

Lord, 1951

Lord, Hage, and Stewart, 1947

Nikolaev, A.V., 1949

Nikolaev, I. I., 1950

Nikol'skaya, 1951, 1955

Parker, 1955

Phillips, 1947

Posnjak, 1940

Posokhov, 1954

Quiring, 1954

Rozen, 1953

Schultz, 1910

Secretary of the Interior, 1955

Shchepetunin, 1937

Teodorovich, 1949

Thode, Wanless, and Wallouch, 1954

Williams, 1952

Surface brines

Bain, 1956

Barbour, 1916

Bergmann, Valyashko, and Feigel'son, 1953

Binyon, 1952

Boury, 1938

Briggs and Lucas, 1954

Carl, 1940

Cordini, 1950

Debyser, 1952

Delecourt, 1946

Dellwig, 1955

Surface brines (cont.)

Dole, 1912

Eardley, 1938

Epshtein and Anferova, 1950

Feodot'ev, 1949

Flynn, 1951

Gale, 1917

Gawel, 1955

Gorbov, 1950

Harbeck, 1955

Haslam, Allberry, and Moses, 1950

Hobson, 1945

Koczy, Tomic, and Hecht, 1957

Kovda, Egorov, Morozov, and Lebedev, 1954

Ladoo and Myers, 1951

Lang, 1957

Luk'yanova, 1953

Masson, 1955

Nikolaev, A. V., 1949

Nikol'skaya, 1951, 1955

Parker, 1955

Phillips, 1947

Posnjak, 1940

Posokhov, 1954

Rawson and Moore, 1944

Rozen, 1953

Schultz, 1910

Scruton, 1953

Secretary of the Interior, 1955

Shchepetunin, 1937

Singewald, 1942

Sloss, 1953

Stewart, 1953, 1954

Strakhov and Zalmanson, 1944

Weaver, 1946

Zdanovskii, 1953

Sweden

Assarsson, 1949

Switzerland

Frei, 1954

Texas

Hanna and Wolf, 1941

Hills, 1942

Macdonald, 1953
Masson, 1955
Parker, 1955

Quarles, 1953

Stewart, 1954

Thode, Wanless, and Wallouch, 1954

Weaver, 1952

Triassic salt beds
- Bourcart and Ricour, 1954
- Dupouy-Camet, 1953

United States
- General
  - Desjardins, 1952
  - Gale, 1912
  - Hance, 1914
  - Ladoo and Myers, 1951
  - Lang, 1957
- Southwest Part
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- Aleksandrov and Levchenko, 1953
- Bergman, Valyashko, and Feigel'son, 1953
- Chirkov, 1937
- Danilova, 1949
- Epshtein and Anferova, 1950
- Feodot'ev, 1949
- Gorbov, 1950
- Kovda, Egorov, Morozov, and Lebedev, 1954
- Luk'yanova, 1953
- Nikolaev, A. V., 1949
- Nikol'skaya, 1951, 1955
- Posokhov, 1954

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- Prikhid'ko, 1951
- Rozen, 1953
- Shchepetunin, 1937
- Strakhov and Zalmanson, 1944
- Vorob'ev and Kadysev, 1951
- Voronova, 1954
- Zdanovskii, 1953

Uses
- Bruggen, 1924
- Lang, 1957
- Schultz, 1910

Utah
- Eardley, 1928
- Imlay, 1952
- Lindberg, 1946

Western Australia
- Hobson, 1945

Wyoming
- Imlay, 1952
- Schultz, 1910