of local structure, faults, and rock permeability. For the area as a whole, the control is entirely lithologic and stratigraphic. Probably the copper was dropped into or precipitated within the original mud; it may conceivably have replaced, with exquisite detail, something else that was so deposited.

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Ammonite Accumulations in the Cretaceous Mowry and Aspen Shales

THE Mowry and Aspen shales, derived in part from the airborne ash of a series of volcanic eruptions, extend from northern Colorado through Wyoming to central Montana. Some ash falls were changed to a clay (bentonite), but the greater part, now more or less silicified, ranges from a rather hard shale where much nonvolcanic detritus is present to a dense porcellanite. At some places the less silicified parts contain calcareous concretions from 8 cm to as much as 2 m in diameter.

The formations are noted for their well-preserved but scattered scales and bones of fishes; other fossils are very rare. At a few places abundant pelecypods, with few ammonites and gastropods, are preserved in porcellanite. Completely flattened molds of ammonites, mostly in porcellanite, have long been known, but because of their preservation are difficult to evaluate. Unflattened ammonites were known from a few localities in northern Wyoming and Montana, but were erroneously attributed to other formations; recent field work has shown that these ammonites are also from the Mowry shale.

The unflattened ammonites are all in calcareous concretions that are alike in certain features. They are usually in a stratum with many others that are nearly barren of fossils, as are also the enclosing rocks. They contain, in parts of the concretions, fish remains so abundant that they form the matrix of the invertebrates. They also contain carbonized wood and a few isolated bones of pterodactyls and marine reptiles.

The ammonites are unoriented and unsorted. Variant shells, from slender costate to stout spinose, are associated, and immature forms 10 mm in diameter are mingled with others 50 mm or more in diameter. In most specimens the living chamber that in life contained the soft parts is missing or crushed, and in many the septate part has been damaged. A phenomenal number of ammonites is present in some of the concretions. One found near Winnecook, Mont., yielded 1300 specimens of gastroplitid ammonites (the largest 270 mm in diameter) and 230 engonoceratids. A second, from Teigen, Mont., yielded 3800 gastroplitids (the largest 400 mm in diameter) and 400 engonoceratids. And a third, from Cody, Wyo., produced 2400 gastroplitids (to 400 mm in diameter) but no engonoceratids. For none of these concretions (each about 6 ft in diameter) is the collection probably as much as half the original content of the concretion. In view of the rarity of the scattered specimens of flattened ammonites in the ordinary beds of the Mowry and Aspen shales, what conditions would produce in a single concentration a mass of unflattened ammonites, fish remains, and carbonized wood? And why would no fossils be found in the many other concretions nearby at that level? The persistence of fossil wood suggests currents that could sweep the shells together, but there has been little sorting, such as currents might produce, and it is difficult to see why all the shells would be concentrated by currents in the small area of one concretion. If ammonites lived in swarms, the mass annihilation of a swarm by some sudden volcanic event could perhaps result in its preservation in one restricted spot, but surely there would be a few stragglers somewhere in the vicinity. To us the most attractive speculation is that these concentrations are aggregations of the fecal matter of some large carnivore (reptile, fish, or cephalopod), a thesis that would explain the damage to the shells, the lack of complete individuals, the lack of sorting, and the disarticulated condition of the fish remains. It would be necessary to postulate that the carnivore fed almost entirely on ammonites and fish and perhaps that, as the living octopus, it frequented a sort of lair, to which it carried its prey for leisurely consumption and in which the mucus-bound fecal matter could accumulate.

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Polarographic Determination of Tungsten in Rocks

THE polarographic determination of tungsten has the advantage of being less tedious and more rapid than the classical gravimetric methods usually used in analyzing rocks and ore concentrates.

The current voltage curve for tungsten, described by Lingane (*1*), using concentrated hydrochloric acid as the supporting electrolyte, gave inconsistent results when applied to rock samples. This inconsistency may be attributed to the formation of polytungstates, and the particular polytungstate formed in a given sample depends on: (*a*) the constituents of the sample, (*b*) the chemical treatment of the sample, and (*c*) if tungsten standard was added to the sample, the manner in which it was added.

However, a new polarographic wave for tungsten in a supporting electrolyte of 4.6 molar hydrochloric acid and 0.1 molar tartrate gave satisfactory current-voltage curves, regardless of the constituents of the sample and regardless of whether the tungsten is that present in the sample or that added as standard to the sample. Tungsten is reduced stepwise; the half-wave potential of the first wave is 0.35 v and that of the second wave 0.68 v versus S.C.E. The diffusion current is directly proportional to the tungsten concentration, but the solutions more concentrated than about 10^{-3} molar exceed the solubility of the tungsten.

In the proposed method the sample is fused with sodium carbonate, leached with water, and filtered. The tungsten is complexed with tartrate and the solution acidified with hydrochloric acid. The percentage of tungsten is calculated from the diffusion-current constant obtained on standard tungsten solutions. Vanadium (whose wave surprisingly overlaps that of tungsten) is complexed with cinnamic acid, and iron is removed by the filtration. Molybdenum, tin, and antimony need to be removed if the molar concentration of any one greatly exceeds that of the tungsten. Any other ions present in the filtrate from the carbonate fusion are either not reduced in hydrochloric acid or their half-wave potentials are more negative than tungsten. Results on samples analyzed both polarographically and gravimetrically are in close agreement.

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Reference

1. LINGANE, J. J. *J. Am. Chem. Soc.* **71**, 943 (1949).

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Geology and Ground Water Resources of the Matanuska Valley Agricultural Area, Alaska

THE agricultural area of the Matanuska Valley lies on a wide valley floor, most of which is formed by glacial deposits. Nonglacial unconsolidated deposits include wind-blown material distributed generally over the agricultural area and slope deposits along the valley walls. Small bodies of perennially frozen ground (permafrost) are present in some bogs.

Till ("hardpan"), possibly of late Wisconsin (Mankato) age, occurs at the surface or beneath surficial outwash gravel deposits in a large part of the valley floor. In several widely separated localities the till is known to be underlain by older glacial gravel, and the presence of an older till beneath this gravel is suspected. Several types of outwash deposits, most of them formed during glacial recession in this area, can be differentiated. Associated with glaciofluvial deposits of existing streams are estuarine deposits of glacial silt. The topography developed on the unconsolidated deposits is due chiefly to glacial deposition, large-scale stagnation of ice, and trenching of glacial deposits by melt-water streams.

Most wells in the agricultural area obtain water from gravel. Supplies sufficient for domestic and farm use are generally available wherever the gravel is saturated. Only little is known of the quantities of water available. Till in this area is relatively impermeable; most wells in till obtain water from included thin sand or gravel layers. Bedrock here appears to be relatively poor water-bearing material.

Recharge of ground water is chiefly from precipitation on the area, but parts of the area receive drainage from adjacent mountain slopes. Seasonal fluctuations of the water table of as much as several feet were observed during the period 1949–51.

Chemical analyses show that the ground water ranges from moderately hard to very hard but is otherwise satisfactory for general domestic and farm uses.

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New Books

Curvature and Betti Numbers. K. Yano and S. Bochner. Princeton, N.J.: Princeton Univ. Press, 1953. 190 pp. $3.00.

An Evaluation of Relativity Theory: After a Half-century. C. A. Muses. New York 3: S. Weiser, 1953. 48 pp. $2.15.

The Achievement Motive. David C. McClelland *et al.* New York: Appleton-Century-Crofts, 1953. 384 pp. Illus. + plate. $6.00.

Vegetation and Watershed Management. E. A. Colman. New York: Ronald Press, 1953. (Sponsored by The Conservation Foundation.) 412 pp. + plates + maps. $7.00.

Microwave Theory and Techniques. Herbert J. Reich *et al.* New York–London: Van Nostrand, 1953. 901 pp. Illus. $10.00.

The Polyporaceae of the United States, Alaska and Canada. Lee Oras Overholts, prepared for publication by Josiah L. Lowe. Ann Arbor, Mich.: Univ. Michigan Press; London: Oxford Univ. Press, 1953. 466 pp. + 132 plates. $7.50.

Hydrocarbons from Petroleum. The fractionation, analysis, isolation, purification, and properties of petroleum hydrocarbons. An account of the work of the American Petroleum Institute Research Project 6. Frederick D. Rossini, Beveridge J. Mair, and Anton J. Streiff. New York: Reinhold, 1953. 556 pp. Illus. + charts. $18.50.

Space Travel. An illustrated survey of its problems and prospects. Kenneth W. Gatland and Anthony M. Kunesch. New York: Philosophical Library, 1953. 205 pp. Illus. + plates. $4.75.

The Zoological Record, Vol. 88. Records of zoological literature relating chiefly to 1951. G. Burder Stratton, Ed. London: Zoological Society, 1953. 19 sections.

Newton's Philosophy of Nature. Selections from his writings. H. S. Thayer, Ed. New York: Hafner, 1953. 207 pp. $1.15.

Science and Man's Behavior. The contribution of phylobiology. Trigant Burrow; William E. Galt, Ed. New York: Philosophical Library, 1953. 564 pp. $6.00.

Keeping and Breeding Aquarium Fishes. C. W. Emmens. New York: Academic Press, 1953. 202 pp. Illus. $4.50.

Highway Research Board: Proceedings of the Thirty-Second Annual Meeting, Vol. 32. National Academy of Sciences–National Research Council Pub. 271. Fred Burggraf and Walter J. Miller, Eds. Washington, D.C.: Highway Research Board, NRC, 1953. 616 pp. Illus. $8.50.