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.

WALTER S. WHITE
JAMES C. WRIGHT

U.S. Geological Survey
Calumet, Michigan

Received February 15, 1954.

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.

JOHN B. REESIDE, JR.
WILLIAM A. COBBAN

U.S. Geological Survey
Washington, D. C.

Received February 15, 1954.

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-