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IMPLICATIONS OF EVAPORITES IN THE UPPER CAMBRIAN-LOWER ORDOVICIAN NOTCH PEAK FORMATION, SOUTHERN HOUSE RANGE, WESTERN UTAH

By

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This report describes a preliminary study of some evaporites that occur in the Upper Cambrian part of the Notch Peak Formation in the southern House Range of western Utah (Taylor and Glanzman, 1979). The occurrences of halite and gypsum were first reported by James F. Miller in a guidebook article published in 1978. Miller implied a primary origin for the evaporites; that is, formation in association with the original depositional environment, but he did not study the deposits in detail.

Occurrences of halite and gypsum have not been documented to our knowledge in other surface exposures of Cambrian rocks in the United States. This makes the Notch Peak evaporites of unique interest and raises questions concerning the original depositional environments of the formation.

The study area is about 3 miles (4.8 km) north of Steamboat Pass in the southern House Range (fig. 1). The area is part of the north-dipping south flank of a syncline formed in Cambrian and Lower Ordovician rocks.

The lower Paleozoic rocks are unconformably overlain by Tertiary volcanic rocks assigned to the Needles Range Formation on a geologic map by Hintze (1974).

The evaporite-bearing interval is about 12 feet (3.7 m) thick and occurs in the middle part of the calcarenite member of Red Tops of the Notch Peak Formation (fig. 2). Trilobites and conodonts date the rocks as belonging to the *Saukia* Zone of the Trempealeauan Stage.

In more detail (fig. 3), the 12-foot (3.7-m)-thick evaporite-bearing interval consists of calcarenite and interbedded shale. The calcarenites consist of ooid, skeletal, and lithoclastic lime grainstones. Most limestones are coarse-grained, with the size of fossil fragments determining the grain size. Some ribbon limestones consisting of centimeter-thick beds of alternating fine-grained lime grainstone and burrowed lime mudstone occur interbedded with calcarenites. Dolostone is absent from the calcarenite member of Red Tops, although a few scattered dolomite rhombs occur in some thin sections.

Halite and gypsum occur as millimeter-thick stringers and as joint fillings, as cement in limestone breccia, and as fillings in vugs a few centimeters in diameter. Length-slow chalcedony is a common constituent of some calcarenite beds.

Fossils are extremely abundant in the limestones and, together with ooids, skeletal grains are the predominant rock-forming particles. Sedimentary structures in the limestones consist of planar crossbedding and ripplemarks. Current ripplemarks having wavelengths of 8-60 cm occur at the base of the section.

The principal outcrop studied shows a natural vertical face with interbedded shale and calcarenite. The shales are predominantly illite with a few stringers of halite and gypsum. Some bedding planes show abundant ferric iron (hematitic) oxidation.

In detail, an evaporite-bearing bed shows halite and gypsum forming the cement of a limestone breccia. The breccia clasts are thin plates of limestone similar in lithology to the surrounding limestone beds. Some halite occurs in centimeter-sized vugs. In some cases, the vugs are formed in an oxidized bed of oolite.

Some beds of fine-grained calcarenite are approximately 4 inches (10 cm) thick. The upper surfaces have been eroded and infilled with granular gypsum and minor amounts of halite.

In some polished hand samples of interbedded illitic shale and fine-grained calcarenite, the shale has millimeter-thick stringers of halite parallel to and cross cutting bedding. Some limestone beds are burrowed.

Some thin sections (plane polarized light) show a clay texture with stringers of quartz silt and voids that were occupied by halite. The halite was lost in preparation of the thin sections, but its presence was confirmed by binocular microscopic examination and by x-ray diffraction.

One thin section shows a contact between shale and fine-grained calcarenite. The veins show the subparallel and cross cutting relations of halite in the rock.

Biogenic activity is closely associated with the evaporite-bearing shales. Some samples have large limestone-filled burrows within the shale. In some instances abundant burrows are subparallel to bedding in the limestones, which are in turn interbedded with shale.

Oolite in beds as much as 6 inches (15 cm) thick is common in the interval examined. Typically, the oolite contains lithoclasts of fine-grained calcarenite and skeletal grains of trilobites, echinoderms, and gastropods. Sponge spicules are observed rarely.

Early diagenetic solution features are common. They consist of partially dissolved and collapsed ooids, and ooids that were completely dissolved except for micrite envelopes which were later infilled with coarsely crystalline calcite spar. Under crossed Nicols, the ooid molds are seen to be filled by single (or a few) calcite crystals. Formation of an early calcite rim cement is suggested. The rim cement is localized on outer surfaces of micrite envelopes and near positions of point contact between grains. Blocky calcite cement filled ooid molds and the remaining intergranular pore space.

Geopetal micritic silt is common in most ooid lime grainstones. Fossil fragments, especially pieces of trilobite exoskeleton, form effective traps for fine-grained geopetal sediment. In another example, a large trilobite fragment trapped bioclastic debris, ooids, and quartz silt above a sheltered void filled with early rim cement and late blocky cement. Some ooid molds show some possible internal geopetal micrite in thin section. Another example shows geopetal micrite trapped at two levels on trilobite fragments. Rim cement and blocky cement are again well developed.

Length-slow chalcedony occurs commonly in the coarse-grained calcarenites. In my observations, it occurs as a replacement of blocky calcite cement. Chalcedony occurs as irregular-shaped masses that have grown at the expense of calcite. The chalcedony has a well-developed reaction rim in areas of contact with calcite, and islands of calcite are often cut off so as to form inclusions in the chalcedony. Calcite inclusions remain in optical continuity with the parent crystal from which they were isolated.

Folk and Pittman (1971) showed that length-slow chalcedony forms as a replacement product during exposure to sulphate-rich fluids. The association of length-slow chalcedony with blocky cement in the calcarenite member of Red Tops suggests that exposure to sulphate-rich fluids was a late event in the paragenesis of the limestones.

Paragenesis of the ooid lime grainstones in the calcarenite member of Red Tops can be summarized as follows:

1) Deposition of ooid-rich sediment in a relatively high-energy, normal-marine depositional environment during the Late Cambrian;

2) Formation of micrite envelopes around ooids and skeletal grains;

3) Precipitation of calcite rim cement;

4) Dissolution of aragonitic ooids;

5) Implacement of geopetal micrite in intergranular voids and in some ooids molds (vadose zone?);

6) Precipitation of blocky calcite cement in ooid voids and in the remaining intergranular pore space; and

7) Exposure of rock to sulphate-rich waters, resulting in

a) oxidation of limestones along bedding planes;

b) cavitation of some limestone beds;

c) replacement of late blocky calcite cement by length-slow chalcedony; and

d) precipitation of halite and gypsum in vugs, in joints, and along zones of permeability parallel to bedding.

Additional indirect evidence against the primary origin for the evaporites includes:

1) Abundance of a normal marine suite of shelly fossils in the associated limestones. Some abundant fossils, for example, echinoderms, have a low tolerance for hypersaline conditions.

2) Abundance of infaunal burrows, some within the evaporite-bearing beds.

3) Absence of appreciable quantities of dolomite in association with evaporites. Evaporite-cemented breccias also lack significant amounts of dolomite.

4) Absence of sedimentary structures associated with a sabkha-type depositional environment.

This evidence suggests that the presence of salt-bearing fluids in association with the calcarenite member of Red Tops occurred at some time after deposition and cementation of the sediments.

Timing of implacement of salt in the calcarenite member of Red Tops is uncertain. However, it is important to note that large quantities of salt are present in the valleys surrounding the salt-bearing bedrock. For example, the Argonaut exploration well, located in the Sevier Desert near Delta (fig. 1), penetrated over 5000 feet of halite and anhydrite. In another case, Salt Marsh Lake, located near Gandy on the west side of the northern Confusion Range (fig. 1), is saturated with respect to halite. Freshwater springs that feed Salt Marsh Lake contain approximately 500 ppm of dissolved solids, whereas the lake contains anomalous concentrations of iron, titanium, boron, and strontium, and significant quantities of lithium, beryllium, chromium, nickel, barium, lead, and several rare earth elements. The suite of trace elements is unaccounted for by simple evaporation of surface waters and may reflect enrichment from buried evaporites at depth.

Age of the buried evaporites is unproven, although the salt body near Delta is probably Tertiary in age. We suggest that the evaporites now occurring in the calcarenite member of Red Tops of the Notch Peak Formation were probably implaced during Tertiary time when salt-rich surface or ground waters were present in western Utah.

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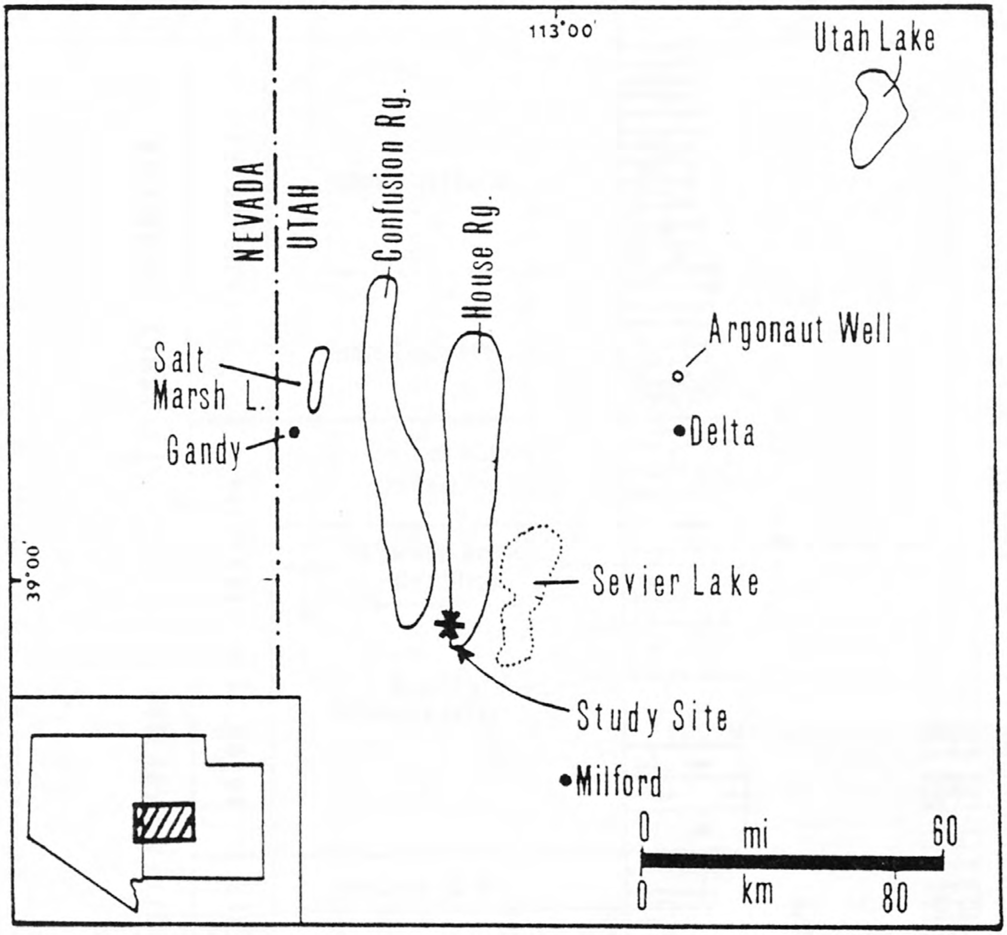

Figure 1.--Index map showing location of study area and of some sites discussed in the text.

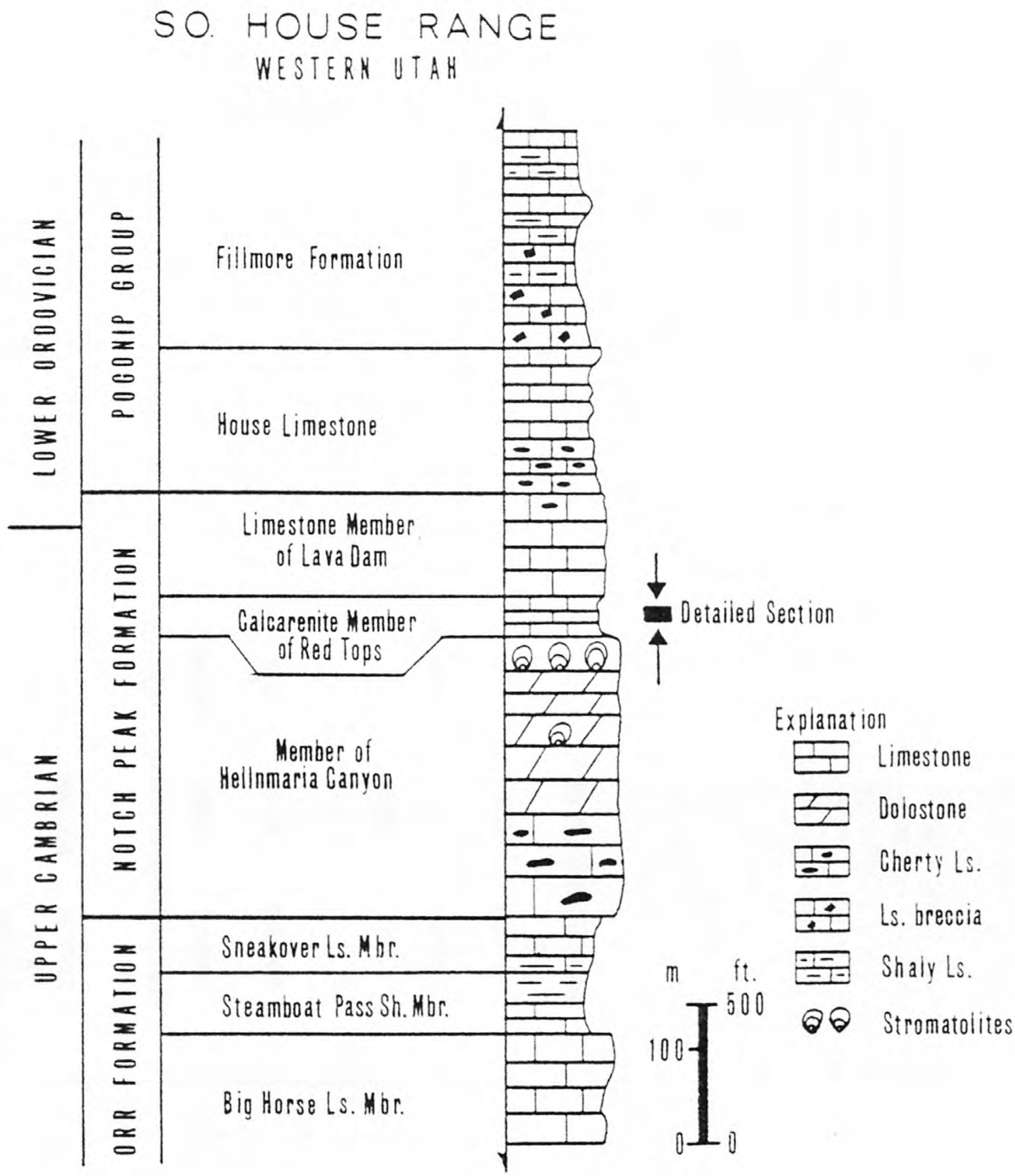

Figure 2.—Generalized stratigraphic column showing the part of the Upper Cambrian and lowest Ordovician rocks exposed in the Steamboat Pass—Lava Dam area of the southern House Range, Millard County, Utah, and the stratigraphic position of a detailed section given in figure 3.

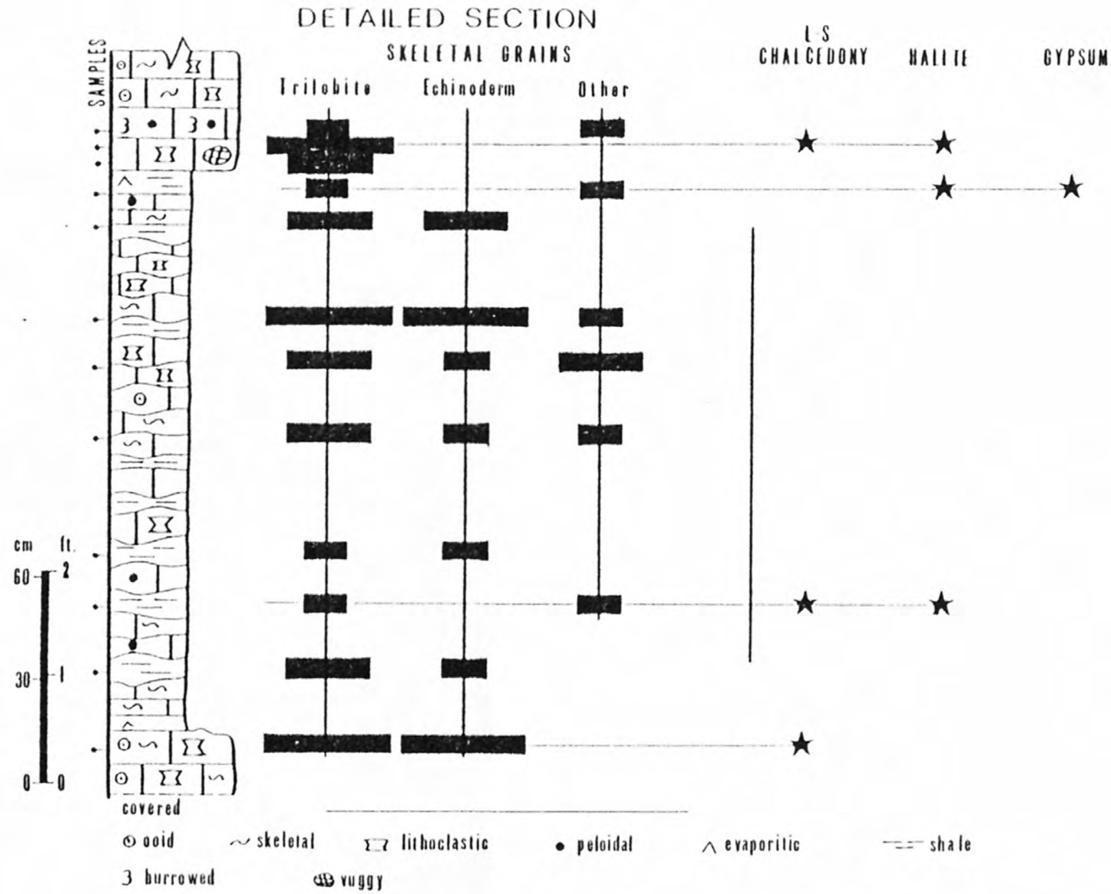

Figure 3.--Detailed stratigraphic section of part of the calcarenite member of Red Tops of Hintze (1974), Notch Peak Formation, that crops out 3 miles (4.8 km) north of Steamboat Pass, southern House Range, Millard County, Utah. Relative abundance of major rock constituents and occurrences of evaporites and length-slow chalcedony are shown.