NOTES AND NEWS

JAROSITE FROM THE CALIFORNIA TERTIARY

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Jarosite-bearing Tertiary sediments crop out along the west side of the San Joaquin Valley in the foothills of Diablo Range, about 10 miles south of Los Banos, California. The mineral has been observed microscopically in Paleocene siltstone of the Martinez formation, and in Eocene glauconitic and laminated sandstone and in diatomaceous shale in the lower portion of the Kreyenhagen formation. In all but the glauconitic sandstone, the grains of jarosite are so minute as to prevent positive identification by ordinary microscopic means; however, larger idiomorphic crystals intimately associated with glauconite yield grains sufficiently large to be identified with the petrographic microscope.

The glauconite-jarosite bed occurs in a basal pebble conglomerate that reaches a maximum thickness of 1–2 feet and is exposed for about one-eighth mile approximately 2½ miles southeast of Ortigalita Creek in Sec. 35, T. 11 S., R. 10 E., M.D.B. and M. Both to the north and to the south the bed is covered by Pleistocene terrace mantle and by minor soil creep from the overlying diatomaceous shale. Further southward along the strike of the beds, jarosite has not been observed in outcrops of similar strata. The pebble conglomerate disconformably overlies anauxitic quartzose sand and brown claystone of the Tesla(?) formation, and grades vertically through approximately 100 feet of greensands, quartzose sandstones, radiolarite, and cross-bedded sandstone and shale into the Kreyenhagen diatomite which in this area is about 700 feet in thickness. Efflorescent gypsum occurs abundantly as thin veins of selenite throughout the section.

Macroscopically, jarosite bears a close resemblance to "limonite" and is difficult to distinguish from limonitic or other ferruginous incrustations in the field. The glauconitic pebble conglomerate is colored a pale yellowish brown by jarosite which binds together the glauconite and other mineral constituents, lending a dull earthy appearance to the rock which in places has a slightly resinous luster, due most likely to patches of more coarsely crystalline jarosite. Nowhere is jarosite coarse enough to enable individual grains to be seen with the hand lens.

Petrography

Most of the jarosite in a thin section of the glauconitic sandstone occurs as drusy clusters, although in voids and in the argillaceous matrix individual grains reach a diameter of 0.01 to 0.05 mm. There is a strong tendency for the mineral to form aggregates of anhedral grains and even the larger and more euhedral grains are characteristically grouped in clusters (Pl. 1). In the rock section studied, jarosite comprises 30–40 per cent of the bulk, the remainder being made up largely of glauconite. Quartz, orthoclase, and irresolvable argillaceous matrix make up less than 15 per cent of the mineral grains.

Glauconite shows a considerable range of optical and textural properties. Whereas most of the grains appear to be granular aggregates of very small crystals, here and there are optically continuous grains with bent micaceous cleavage and characteristic ovate outline (Pl. 1, Fig. 1). The optic angle varies from 0° to 25° ±5°. Pleochroism was noted with X = pale yellowish green, Y and Z = olive-green, with $Z \geqq Y > X$. Upon weathering, glauconite assumes various shades of greenish brown, presumably due to the formation of ferric hydroxide. Most of the grains in the samples studied show some degree of weathering.

Of particular interest is the occurrence of jarosite within the glauconite, or drusy patches of jarosite enclosing scattered fragments of glauconite that are optically continuous. In fact all of the intermediate relationships between these two minerals may be observed in a single thin section. There can be little doubt that jarosite has replaced the glauconite.

Separation and Properties of Jarosite

A fair separation of jarosite from the other mineral constituents of the rock was made by disaggregation, sieving, and centrifuging the fraction finer than the 200-mesh Taylor sieve with bromoform (density 2.80). However, glauconite containing jarosite and pure jarosite could not be separated in this manner, nor could jarosite be further concentrated by its magnetic properties in the Frantz separator. Material thus obtained was used to determine the lower refractive index (N_e) which distinguishes potassium jarosite from natrojarosite and other members of the jarosite group. The optical properties are as follows:

$N_e = 1.714 \pm 0.003$
$N_0 > 1.81$
Uniaxial—.(The typical division of the basal section into six biaxial segments was not observed).
X = very pale greenish yellow.
Z = deep golden yellow.
$Z > X$.
$N_0 - N_e = 0.1$ *ca.*, extreme birefringence.

Measurements of interfacial angles were made with use of the universal stage, giving angles of approximately 55° and 91° which agree closely with those recorded by Ford (1932, p. 769) for jarosite (*rr′* $(10\bar{1}1 \wedge \bar{1}101)$ $= 90°45'$, *cr* $(0001 \wedge 10\bar{1}1 = 55°16')$.

PLATE 1

FIG. 1. Photomicrograph of jarosite-glauconite sandstone showing dark patches of anhedral jarosite and larger euhedral grains (with dark borders). Larger ovoid grains are glauconite which photographs in various shades of gray. Note the vermicular glauconite with strong cleavage in the lower portion of the photograph, and the mixture of jarosite and glauconite in the upper right. Distance between marks on the scale is one-tenth millimeter. Magnification 70×.

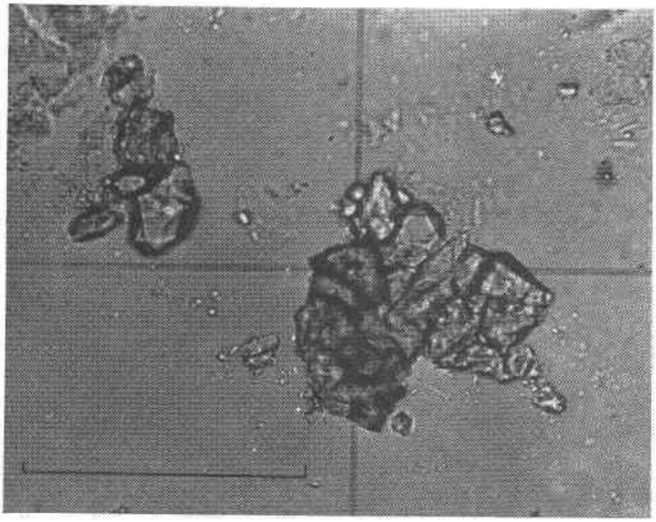

FIG. 2. Photomicrograph of the central portion of Fig. 1, much enlarged, showing facets on the jarosite crystals and the common occurrence of the mineral in clusters. Grains such as these were used to measure interfacial angles. Distance marks on the scale is one-tenth millimeter. Magnification 375×.

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One characteristic property of the minute grains is their symmetrical extinction observed on rhombohedral crystals which do not show the development of the basal pinacoid. The basal pinacoid is characteristic of larger grains, which indicates that rhombohedral faces are the first to develop and that subsequent growth of the crystal is more rapid along directions perpendicular to the *c*-axis, leading to the tabular form of the larger grains.

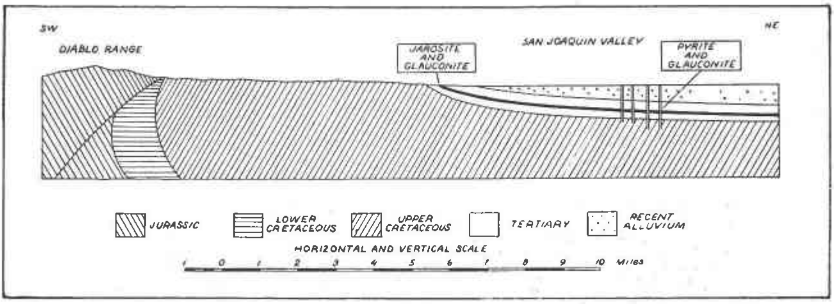

FIG. 1. Structure-section across the eastern foothill belt of Diablo Range and a part of the adjacent San Joaquin Valley. Distribution of the glauconite-rich Tertiary strata is shown by the heavy black line. Pyrite is found with glauconite in well borings beneath the San Joaquin Valley and jarosite is found with glauconite where the strata outcrop in the foothills.

Origin

The intimate occurrence of jarosite with glauconite in a section of Tertiary sediments that is characterized by greensands leaves little doubt that jarosite is formed from glauconite.* The common association of efflorescent gypsum in this same stratigraphic section, in fact in the entire Cretaceous and Tertiary section, which in this area is over 40,000 feet in thickness, indicates a common genesis for both minerals. It is probable that reaction of sulfate-bearing interstratal solutions with glauconite has led to the formation of jarosite from glauconite-bearing sands and shales, and to the formation of gypsum from calcareous tests of micro-organisms contained in the Cretaceous and Tertiary shales. The sulfate ions very likely originated from the oxidation of pyrite such as was suggested for the Glenwood formation by Stanley A. Tyler (1936, p. 72). Cores from wells bored in the adjacent San Joaquin Valley contain considerable pyrite in the form of pyritized spots, foraminifera, and plant

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* Stanley A. Tyler (1936, p. 59) described similar relations between glauconite and jarosite existing in the Glenwood formation overlying the St. Peter sandstone in Wisconsin.

remains, and in all records to which the writer has access the pyrite-bearing beds are interstratified with glauconite-bearing beds, indicating that glauconite and pyrite are stable in the buried sediments (Fig. 1). Pyrite has not been observed in the outcrop area. In all, over 60 thin sections and 20 heavy mineral separations of Cretaceous and Tertiary sediments were studied, and in none of the specimens is pyrite present. Furthermore, S. N. Daviess (1946) noted pyrite in heavy mineral assemblages from well cores in this area but did not observe jarosite, thus it is reasonable to assume that jarosite does not exist in the deeply buried sediments.

Conclusion

The formation of the hydrous sulfate of potassium and ferric iron, jarosite, in Tertiary sediments along the west side of the San Joaquin Valley is a near-surface diagenetic process involving the reaction of sulfate-bearing interstratal solutions with glauconite. Efflorescent gypsum in the same strata very likely is formed coeval with jarosite by reaction of these solutions with calcium carbonate tests of micro-organisms. There is reasonable assurance that the sulfate ions are released to the interstratal solutions by oxidation of pyrite, present in beds of the same formations beneath the San Joaquin Valley.

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FLUID INCLUSIONS IN BERYL AND QUARTZ FROM PEGMATITES OF THE MIDDLETOWN DISTRICT, CONNECTICUT

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During the past year and one-half, the writers have studied fluid inclusions in quartz and beryl from 9 pegmatites of the Middletown district, Connecticut (Cameron and Shainin, 1947), in an attempt to determine the role of temperature in the formation of the pegmatites. The visual method, by which inclusions are observed under the microscope during heating, has been used exclusively in the study. Each temperature