# THE OCCURRENCE OF LEUCOXENE IN SOME OF THE PERMIAN MID-CONTINENT SEDIMENTS

LEVI S. BROWN, *University of Texas.*

The mid-continent sediments referred to in the title are found in South Central Oklahoma. The formations strike due north and south, and for considerable distances across the strike are alternately sandstones and shales. All are Permian in age, and prevailingly red in color.

In the course of a petrographic study of the sandstones, carried on during the past two years, leucoxene was found in considerable abundance. The universal distribution of titaniferous minerals, especially ilmenite and rutile, renders the occurrence of leucoxene in any locality of relatively small moment. However, the unusual amounts occurring in these sediments presented peculiar opportunities for further study, and it is hoped that the ensuing descriptions may be valuable diagnostics of its detrital varieties.

A word is necessary concerning the laboratory treatment to which the sands were subjected. Disintegration of the sands and solution of the ferruginous material coating the grains was effected by boiling with 20 per cent. hydrochloric acid, ten to twenty-five minutes being necessary for clarification. After drying, the heavy minerals were concentrated by suspension in bromoform (sp. g. 2.863), the average crop being a little less than 1 per cent. Of this crop, from 35 to 78 per cent. was made up of leucoxene. Unaltered ilmenite and rutile were also present, the former from 2 to 7 per cent. and the latter from 2 to 5 per cent. These percentages are derived from grain counts of microscopic fields.

The grains of leucoxene appear in a great variety of forms. They are rounded grains or irregular masses, white, yellowish white, to deep reddish brown in color, and may be solidly one color or a mixture of colors, distributed in regular or heterogeneous fashion. Often the grains are tabular and laminated, possessing alternately light and dark colors. Sometimes there are two sets of laminations, the traces forming two sets of fine lines, intersecting at about 60°. Occasionally laminations of unaltered ilmenite appear.

"Pitted" surfaces are common. Milner[1] says, "a rough, 'pitted' surface is characteristic of most grains." I am not sure just what

[1] Milner, H. B.; Sedimentary Petrography, (1922) pp. 59–60.

type of pitting Professor Milner has in mind. These grains exhibit minute openings or spaces within the grain itself, the perforations sometimes extending completely through the grain. In shape, the openings may be hollow spherical, thin lenticular, or acicular. They may appear in regular design or in almost any disorder, though it is to be noted that irregular arrangement is confined to equidimensional openings. The lenticular and acicular openings are always with their longer diameters parallel, but may be closely spaced or liberally separated. Sometimes there are two, or even three, sets of these openings, which appear, on flattened surfaces, as fine striations, and these invariably intersect at about 60°. The other type of pitting is that of a very rough, "flecked" surface. It is apparently due to attrition, but whether in transport or due to laboratory treatment is not clear. The many small flakes of leucoxene found evidently result from this comminution.

I believe some basis for classification of the varieties of leucoxene can be found in the texture or structure exhibited. In all of the foregoing varieties the mineral is amorphous, or so finely divided as to appear so. In another type the structure is microcrystalline, the acicular microlites being clear, light yellow in color. These are arranged in parallel masses, and grouped into bundles. Again, invariably two, and sometimes three, sets may be discerned, these intersecting at 60°, resembling a very compact sagenite.

While these two types of structure may include all varieties, it is to be noted that all gradations between the two may exist. Both types may be present in the same individual, and in any proportion.

As an alteration of ilmenite and rutile, leucoxene may be spoken of properly as a pseudomorph after these minerals. On account of the ready alteration of these minerals, one to the other, it is not always easy to say from which of the two the leucoxene in sediments was derived. If unaltered cores could be seen, it might leave no doubt, in special instances, but these do not often appear. In the few cases here observed, the core was usually of rutile, but this can not be accepted as a criterion for all. However, a knowledge of the occurrences and structures in which ilmenite and rutile may occur is a valuable aid in identifying the form assumed by the leucoxene.

Pure ilmenite and pure rutile alter to the cream-white, opaque, seemingly-amorphous material so commonly described as leu-

coxene. But pure ilmenite is rarely found. Its associates are universally magnetite and hematite. With either of these it seems to exist in isomorphous relationship, within narrow limits. Without these limits the minerals crystallize separately in those varied structures previously described by Professors Warren,[2] Watson and Taber,[3] Singewald,[4] and Hussak,[5] which structures, or patterns apparently are largely controlled by the ilmenite rhombohedron. Basal flakes (and thin sections or polished surfaces studied and recorded in the literature referred to) therefore plainly exhibit trigonal symmetry, and the 60° angles observed. It is probable, also, that with abundant magnetite the octahedron may become prominent, and here again the traces of intersecting faces are at 60° angles.

In the laboratory treatment with hydrochloric acid, magnetite is dissolved out, ilmenite is insoluble, and hematite slowly or difficultly soluble; and the resulting structures in leucoxene are replicas of those descriptions of the original ores above quoted. The "pits" previously described are solution cavities formerly occupied by magnetite. The red coloration in some leucoxenes, according to Rosenbusch, has been shown by Cathrein to be "due to the mechanical mixture of rutile in the form of sagenite, which already existed intergrown with the ilmenite." But the dark-colored grains here give no evidence of such a structure. The red color strongly suggests disseminated hematite, whose difficult solubility is in harmony with this conclusion, and the structures observed are entirely in accord with Professor Warren's descriptions of hematite-ilmenite intergrowths.

[2] Warren, Charles H.; On the Microstructure of Certain Titanic Iron Ores; *Econ. Geol.*, Vol. 13 (1918) p. 419.

[3] Watson and Taber; *Bulletin No.* III-A, *Virginia Geol. Survey.*

[4] Singewald, J. T., Jr.; *Bulletin* 64, *U. S. Bureau of Mines.*

[5] Hussak, E.; *Neues Jahrb. Min. Geol. Paleon.*, Vol. 1. 1904, p. 94.