SOME STAGES IN THE DISINTEGRATION OF GLAUCONITE

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Introduction

Specimens of glauconitic sands upon which this paper is based were collected in the vicinity of Stafford Court House, Virginia, and at Woodstock, on the south bank of the Potomac River, 31 miles east of Fredericksburg. The horizon for all these specimens except one is the Aquia formation, or lower Eocene. One specimen from the Nanjemoy has been studied. The material to be considered is consolidated, thin sections of which have furnished excellent grains of glauconite.

This region forms the northern most exposures of the Virginia Eocene belt which is an extension of the same beds from Maryland.

The earliest studies on the Virginia Eocene were those of William B. Rogers and later by N. H. Darton, W. B. Clark and others.

Types of Sediments Carrying Glauconite

Glauconite occurs principally as amorphous, loosely granular, or massive grains disseminated in sands, sandstones, and clays. It is more rarely found in limestones and as green earth filling cavities in erruptive rocks.

Arenaceous materials, particularly sand, when mixed with glauconite are known as greensands. The term is commonly used to embrace argillaceous deposits as well, but strictly speaking, greensand is sand characterized by the presence of the mineral glauconite.

Associated Minerals

The minerals commonly associated with glauconite in order of their importance are: quartz, feldspar, hornblende, magnetite, augite, zircon, epidote, tourmaline, garnet, and other minerals in smaller amounts. Clay and fragments of continental rocks such as gneiss, mica schist, granite, and diabase may be present. If greensand is distinctly calcareous it is generally called greensand marl. Phosphate of lime frequently occurs in greensand deposits and acts as a cement in binding the smaller grains of glauconite together, thus forming nodules.

Physical Properties and Origin

Glauconite grains are usually well rounded and at times mammillated, whereas the other minerals present in greensands are, for the most part, angular. The color of glauconite grains is usually black or dark green when fresh, and brownish when altered. According to Dana the hardness is 2 in Mohs's scale of hardness, and is easily crushed. Its specific gravity varies from 2.29 to 2.35. Fine punctures sometimes occur on the surfaces of the grains, indicating the punctate nature of the foraminifera tests in which they were formed. At other times they show smooth and shiny surfaces. More generally the surfaces are dull and irregular in outline. In size the grains average 1 mm. in diameter.

In 1855 Ehrenberg first showed the relationship between greensand and foraminifera. His studies were based on material sent him by Professor J. W. Bailey, who in 1845 found large numbers of foraminifera in various Cretaceous and Tertiary marls of the United States, and called particular attention to the occurrence of casts of the shells in the Eocene at Fort Washington, Maryland. Ehrenberg attributes the formation of greensands to the filling up of the interior space of minute bodies, particularly foraminifera, with a green colored opal-like mass, which forms a cast. This peculiar natural injection is often so perfect that the large cells, and even the finer divisions, are petrified and separately exhibited. Such fine and perfect injections could not be formed by any mechanical method.

Professors Murray and Renard in their report upon the deep-sea deposits they obtained from the Challenger expedition of 1872–76, give a very satisfactory explanation of the formation and origin of glauconite which will not be reviewed here.

The mineral glauconite is essentially a hydrous silicate of aluminum, iron, and potash. Because of its green color it was assumed for a long time that all the iron was in the ferrous state, but a study made of the New Jersey greensands, following the suggestions of Professors Dana and Brush, showed that nearly four-fifths of the iron is in the ferric condition.

It is the general consensus of opinion that glauconite is a secondary chemical deposit of marine origin. Its association with foraminifera and other organisms is so intimate that its marine origin seems unquestionable. In many instances glauconite grains are distinct internal casts of these organisms, although in the Virginia

Eocene deposits foraminifera casts are less distinctly seen than in more recent deposits.

Glauconite is only formed in the presence of land-derived materials, and for this reason is restricted in area to regions in proximity to the shore where deposition is slow and the sediments have been extensively decomposed by long exposure to marine water. Large rivers flowing into the sea or strong currents carrying sediments interfere greatly with its formation and prevent continuous distribution for any great distance, and may indeed cause its formation to cease altogether.

It has been estimated that approximately 1,000,000 square miles of sea floor are now covered with glauconite deposits. The depth is usually between 100 and 200 fathoms, although it has been found at depths as great as 900 fathoms.

Greensands of the Virginia Eocene

The Eocene deposits of Maryland and Virginia consist largely of greensand marls which on weathering lose their characteristic green color and become buff colored sands, discolored and cemented in places by hydrous iron oxide. In Virginia the Eocene strata attain a thickness of 225 feet. The strike of the formations is almost due north and south, the beds having a gentle dip to the east of from 12 to 15 feet to the mile. The greensands are largely unconsolidated. Layers of indurated greensands occur along the bluffs near the mouth of Aquia Creek and a local development of silicified ledges is present in the vicinity of Stafford Court House and Brooke. Aside from these occurrences the greensands of the Virginia Eocene are not consolidated except as nodular concretions.

The Eocene sands vary from light to dark green depending on the degree of weathering and amount of water present. The more weathered sands are stained brown by iron oxides. Quartz is the most abundant mineral in addition to glauconite. Small angular grains of muscovite give a glistening appearance to much of the greensand. Irregular grains of magnetite, feldspar, and fragments of comminuted shells are also present.

Associated Fossils

The fossil faunas associated with the consolidated material are principally molluscan forms preserved as silicified and calcified, casts, molds, and imprints. The following species have been identified.

Turritella mortoni Conrad
Lunatia marylandica? Conrad
Calyptraea aperta Solander
Strepsidura subscalarina Heilprin
Tudicla?
Meretrix ovata Conrad
Panopea elongata Conrad
Phenacomya petrosa Conrad
Cucullaea gigantea Conrad
Ostrea sp.

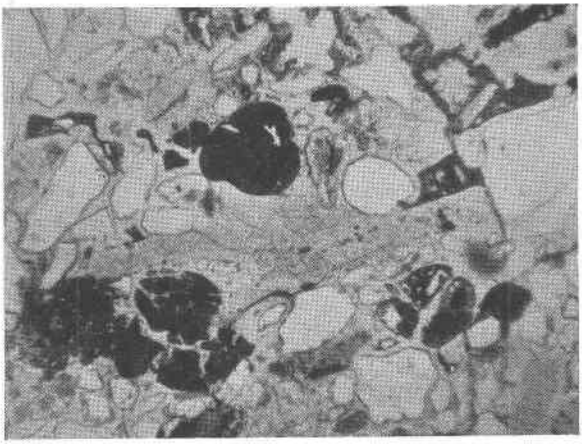

FIG. 1. Photomicrograph showing altered glauconite grains and angular quartz in a dense opaline groundmass. Some of the grains are highly fractured, while others are unbroken. X 26.

Some of the Stages of Disintegration

As seen in thin sections glauconite occurs as scattered irregular grains and masses in an opaline groundmass which is thickly studded with angular grains of quartz. The grains always have a smooth rounded edge, even when fractured. They vary from light to dark green in color when fresh, and from light yellow to dark brown when altered. In size the grains rarely exceed 1 mm. in diameter. The shape of the glauconite grains is of no one particular type or types. In the majority of observations made two shapes were noticeable, namely, the somewhat equi-dimensional and the elongated grains, the latter being somewhat sack-shaped.

The glauconite grains appear fractured or broken in various ways; the fractures may extend through the entire grain, they may be limited largely to the periphery, they may be observed chiefly in the interior, and in a number of instances the grains showed a sheared or shredded pattern. This fracturing is difficult to explain as due entirely to movements in the sediments and rocks as some grains were badly fractured while adjacent grains were unusually free from fractures as illustrated in figure 1.

Weathering has, in the majority of cases, accompanied this shattering process. In the elongated grains this weathering sometimes is oölitic in character, in which the dark brown to black

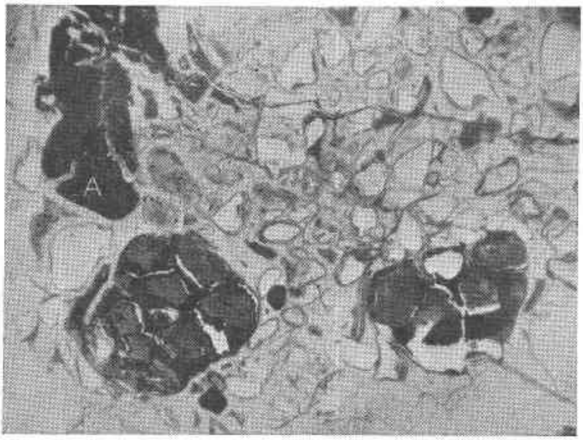

FIG. 2. Photomicrograph showing fractured glauconite grains replaced by hydrated iron oxides. The grain indicated by "A" has been completely replaced. X 26.

oölites consist of hydrated oxides of iron. In those specimens in which the fracturing involves the entire grain, as in figure 2, limonite or some other hydrated iron oxide has replaced the glauconite along the fractures, forming an opaque zone surrounding the less weathered glauconite. In some cases the entire grain has altered to limonite (Fig. 2) and it is to be noted that iron oxide may also occur throughout fragments of the grain more or less uniformly disseminated. In those cases in which the grain appears to have been sheared, the fractures are generally arcuate or almost straight; and the weathering manifests itself by alternate parallel bands of light and dark green to brown colors. In some glauconite grains irregular masses of iron oxides occur as inclusions.

Thus, the suggestion offered for the fractured condition of the grains is that it may be due, to some extent, to processes of weathering and the pressure developed by the growth of the hydrated iron oxides. It is conceded that stresses and strains brought to bear on the rocks have also been contributing factors.