MELILITE - NEPHELINE-BASALT AND NEPHELINE-BASANITE FROM SOUTHERN TEXAS.

These basaltic rocks were collected by Professor Dumble and Mr. Taff, in Uvalde County, southern Texas. On the geological map of the United States, compiled by C. H. Hitchcock, 1886, there are two of the localities marked near the boundary of the Cretaceous and earlier Tertiary formation, between 99° and 100° longitude, and on the 29th degree of latitude. According to the statement of Professor Dumble, one part of the rocks appears in dikes in the upper portion of the lower Cretaceous formation, while the other forms hills and buttes. Upon microscopical examination it is evident that the specimens collected belong to two different groups of rocks. The microscope shows that those occurring in dikes consist of typical melilite-bearing nepheline-basalt, while those making up hills and buttes are nepheline-basanites tending toward phonolites in composition.

The melilite-nepheline-basalts have a typical basaltic appearance. In a dense black groundmass, the only phenocrysts seen by the naked eye are numerous olivines. Under the microscope there appear in addition to the olivine the following minerals: augite, nepheline, melilite, magnetite and perovskite. As to the proportion of nepheline and melilite, it can be said, that in nearly all the specimens examined, the two minerals are found in about the same amount. For this reason these rocks can be placed under the head of nepheline-basalt as well as under that of melilite-basalt, or they may be called melilite-nepheline-basalt. Only one of the specimens is entirely free from melilite. Feldspar is wholly wanting. All of the specimens are in a very fresh condition, and even the melilite shows only slight indications of decomposition. The specimen free from melilite corre-

sponds in structure and composition with the other specimens, except for the absence of melilite and perovskite, and so they may be described together.

All the rocks are porphyritic, since they bear large phenocrysts of olivine. Under the microscope the olivine is colorless and transparent, and only shows indications of serpentinization along the edges and fissures. It contains rounded inclusions of glass, abundant in some sections, besides octahedrons of magnetite, and others that are transparent with a brownish violet color. Whether the latter are a mineral of the spinel-group or belong to perovskite, with which they accord in color, could not be decided.

Augite occurs in only one generation; phenocrysts of augite are wanting. In the rather coarse-grained groundmass, it becomes the most abundant constituent. The mineral shows a grayish-brown color, common to basaltic augite, sometimes with a tint of violet. It generally forms well-shaped crystals, rarely irregular grains, and bears inclusions of magnetite and glass.

Melilite occurs in the groundmass in large and well-shaped crystals, its dimensions never becoming as small as those of many of the augite crystals. They may be designated as microporphyritical phenocrysts. Cross sections parallel to (001) reach a diameter of 0.5 mm. The shape of the melilite is the common one, tabular parallel to (001). The diameter of the tables generally exceeds their thickness from four to six times. Sections parallel to the prism-zone, therefore, are lath-shaped and the vertical axis lies perpendicular to their length; the axis of greatest elasticity coincides with the vertical axis. Between crossed nicols these sections show the particular blue interference colors characteristic of melilite and zoisite. Sections perpendicular to the prism-zone are eight-sided by reason of the planes (110) and (100), but frequently the outlines are rounded. In some of the sections examined the melilite incloses minute opaque grains arranged zonally, which present very sharply the prismatic outlines of their host. Besides the two prismatic faces above mentioned, there is also a ditetragonal prism, the angle of which upon the adjoining faces of (110) and (100) was found

to be nearly equal, 20° – 22° . According to this measurement the prism must have approximately the position of (940); the angle of the latter upon (110) is $21^{\circ} 2'$, the angle upon (100) = $23^{\circ} 58'$. A particular phenomenon in the growth of the melilite is the fact that the base does not generally present an even plane, but shows a conical depression. The shape of the lath-shaped sections then resembles the profile of a biconcave lens. Sections parallel to the base are isotropic between crossed nicols and show, when they are not too thin, an indistinct dark cross in convergent light. The cleavage parallel to (001), the cross-fibration of the lath-shaped sections and the occurrence of the spear-shaped and peg-shaped inclusions arranged parallel to the c axis (the so-called *Pflockstruktur*) are very distinct. Inclusions of pyroxene, magnetite and glass are common; as already mentioned, these inclusions are generally arranged in zones. In sections parallel to (001) they fill the central parts of their host, and often make up two or three concentric zones. These sections closely resemble leucite because of their rounded shape, the arrangement of the inclusions and the lack of double refraction. Melilite becomes nearly colorless and transparent, but in comparing it with the white, colorless nepheline, it shows a feeble yellow tint. Decomposition has taken place to only a small extent; it begins along the cross-fibration, and greenish-yellow alteration-products result, the fibres of which are perpendicular to the length of the lath-shaped sections.

Nepheline is always fresh, colorless and transparent; it rarely exhibits a regular shape, but generally forms an aggregate of irregular grains, cementing the other components; it is evidently the latest formed mineral in the rock.

There is abundant magnetite besides perovskite, the common associate of melilite, which occurs in small octahedrons and irregular grains. The perovskite becomes transparent with a brownish-violet color, and shows in some sections a feeble, abnormal double refraction. There appears to be no isotropic base in the normal rock, but if any is present, it must be in a very small amount. There are coarser grained spots in the rock,

which are rich in a partly chloritized base, and in which nepheline occurs in well-shaped crystals.

The second group of rocks, as already mentioned, falls under the head of nepheline-basanite poor in olivine. And since the specimens bear sanidine phenocrysts beside plagioclase, it forms a transition to phonolite. The rock-specimens have a more andesitic than basaltic appearance. Numerous phenocrysts of hornblende and augite are imbedded in the dense bluish-gray groundmass. The next most abundant mineral is nepheline in the form of phenocrysts, in part well-shaped crystals, in part rounded, the largest of which are 0.5 cm. in diameter. The nepheline differs from the feldspar in having a grayish color and greasy lustre. Phenocryst of feldspar and crystals of olivine are scarce. Beside these components, the rocks contain apatite, some titanite and iron ores. Under the microscope olivine is seen to be scarce. It is fresh and shows the normal properties. It contains minute octahedrons of picotite and in some sections abundant inclusions of a liquid with moving bubbles.

The amphibole mineral is a typical basaltic hornblende. It becomes transparent with a dark reddish-brown color and exhibits a strong pleochroism according to the following scheme:

a, brownish yellow, b and c dark reddish brown. Absorption, $c > b > a$.

The angle of extinction was examined in sections cut approximately parallel to the clinopinacoid (010) and was determined to be very small. This fact and the dark reddish-brown color are in all probability due to a high amount of Fe_2O_3 . The dependence of the angle of extinction upon the amount of Fe_2O_3 in minerals of the amphibole group has been recently established by Schneider and Belowsky. The basaltic hornblende shows the well-known dark borders produced by reabsorption by the magma in an early stage of consolidation. In many cases nothing of the original mineral is preserved; the whole hornblende is replaced by a fine grained aggregate of pyroxene and magnetite, presenting clearly the outlines of the absorbed mineral.

The group of pyroxenic minerals is represented by two mono-

clinic augites. One of them exhibits a violet-gray color in thin section and belongs to the basaltic augites; the other one becomes transparent with a dark green color. Both form numerous phenocrysts, but the first occurs somewhat more frequently. They occur as single crystals and are also grown together in a zonal manner, the green one always forming the center, the gray one the outer parts of the crystals. Hence the gray augite is the younger. The pyroxene in the groundmass shows the same color and properties. The pleochroism of the two minerals is as follows:

Gray augite.		Green augite.	
a	Brownish-yellow		Light yellowish-green
b	} Violet-gray		Dark gray-green.
c			Dark green.

The angle of extinction, $c: c$, is large and, as may be seen in the zonal crystals, it is somewhat larger in the gray pyroxene than in the green. The extinction in sections cut approximately parallel to (010) has been observed to be about 47 degrees (gray augite) and 41 degrees (green augite). The two pyroxenes show in addition to the cleavage parallel to (110) another but less distinct one parallel to (010). Inclusions of magnetite, apatite and glass are common.

Phenocrysts of feldspar are scarce. In part they show the polysynthetic twinning lamination of plagioclase; in part the latter is wanting and one of the latter feldspars, which was isolated and examined for specific gravity and optical properties, was found to be sanidine. Phenocrysts of nepheline are more frequent than those of feldspar. The mineral appears partly in the form of short-prismatic crystals, partly in rounded grains. It presents distinct cleavage, parallel to (1010) and to (0001), and the usually observed optical properties. Isolated grains are decomposed by hydrochloric acid with the separation of gelatinous silica; the resulting solution when evaporated gives numerous cubes of NaCl. Inclusions are scarce; there are fluid cavities with moving bubbles, generally arranged in rows, besides some pyroxene crystals.

Apatite forms short and stout crystals always filled with in-

clusions of liquids. The opaque ore grains, judging by their ready solubility, belong to magnetite. The groundmass of these rocks consists essentially of pyroxene in well-shaped prisms, lath-shaped feldspar, without twinning lamination or in single twins according to the Carlsbad law and nepheline. The feldspar of the groundmass in all probability is mostly sanidine. Nepheline is abundant and occurs in well-shaped crystals. Small patches of a colorless base occur between the crystalline components.

The structure of the rocks is hypocrystalline-porphyritic on account of the occurrence of an isotropic base and the repetition of the crystallization of pyroxene, nepheline and feldspar. Although the specimens by their whole habit and structure belong under the head of nepheline-basanite poor in olivine, the presence of sanidine as phenocrysts causes them to form a transition to the group of phonolites. Unfortunately, analyses of these rocks have not yet been made.

A microscopical examination of the basaltic rock from Pilot Knob, near Austin, Travis County, was made for the purpose of comparison with the rocks from southern Texas just described. The rock was found to be a nepheline-basalt porphyritic with numerous phenocrysts of olivine. The fine grained groundmass consists essentially of augite-crystals cemented by non-individualized nepheline in very small amount.

A. OSANN.