ART. XXXI.—*On an Occurrence of Theralite in Costa Rica, Central America*; by J. E. WOLFF.

AMONG a series of rocks collected by Prof. R. T. Hill in 1895 in a reconnaissance of the Isthmus of Panama and Costa Rica made in coöperation with Mr. Alexander Agassiz, was one small specimen occurring as an intrusion through the Tertiary rocks of the Atlantic slope of the Costa Rican volcanic plateau. Of this specimen Mr. Hill says: "The rock is pushed up through the Upper Oligocene strata [limestone] and hence its age is Miocene or later." According to his diagram, it occurs as a large mass cutting across the bedding of the limestone.

The rock has the typical spotted dark gray color of the Montana theralite with distinct crystals of augite, biotite and rounded areas of radiating zeolites.

In thin section the rock is composed of augite, triclinic feldspar, sanidine, nepheline, a mineral of the sodalite group, olivine, biotite, magnetite, apatite, and abundant zeolites. The augite occurs in imperfect prisms with both pinacoids and terminal planes; it has a pale yellowish-green color with marked zonal structure and an extinction of 43° on the clinopinacoid. In a large section cut across the prism the inner lighter green core has the orthopinacoidal cleavage alone developed, while the outer zones have the usual double prismatic cleavage alone developed, showing an apparent relation between the development of these cleavages and the chemical composition. Ægirine as an outer border or separate from the augite is entirely wanting. The few imperfect crystals of olivine are entirely serpentinized. The biotite occurs in hexagonal plates; the apatite and magnetite require no special description.

The feldspar is the most striking constituent in comparison with the Montana theralite, for the larger part shows multiple twinning on the albite law, with rarely a pericline lamella; even apparent Carlsbad twins are found by optical study to be on the albite law analogous to the well-known occurrence of albite itself in the crystalline schists, and the Carlsbad law seems to be wanting. By means of the Federow universal stage a number of these feldspar sections were brought into the zone of optical symmetry and by revolution on the second horizontal axis the maximum negative extinction of this zone determined at between 26° and 27° *; the feldspar is therefore a labrado-

* The use of this instrument is especially helpful in such cases where the use of the excellent methods of Michel-Lévy (combination of the albite and Carlsbad laws) or of Fouqué (bisectrix sections) is impracticable. Prof. Federow has rendered a service to petrographers comparable to that of Goldschmidt, himself and others to crystallography in the invention of the theodolite goniometer.

rite of the composition $\text{Ab}'\text{An}'$. A few sections of untwinned feldspar have an index of refraction inferior to that of the balsam, a small axial angle, and are therefore probably orthoclase.

The mineral of the sodalite group occurs exactly as in the Montana rock in little crystals enclosed in the feldspar, with a dirty blue color, isotropic character and characteristic square or hexagonal outlines. The nepheline is in small stout square prisms, generally in clusters or enclosed in the feldspar—the usual fibrous decomposition has obscured the original optical properties, but its entire identity in form and characters with the nepheline of the weathered specimens of the Montana rock, leaves no doubt as to its identification. Zeolitization has spread from the nepheline to a large part of the feldspar; most of the zeolites are of the radiating prismatic type, which was not further determined, but there are some patches of analcite.

The main differences from the Montana type are in the absence of ægirine, the distinctly basic soda-lime feldspar and the small amount of sanidine; it probably represents a type poorer in alkalis, but a chemical analysis was considered unremunerative on account of the small amount of material and considerable alteration of the rock. It represents the purest type yet described of theralite as defined by Rosenbusch, namely a soda-lime feldspar-nepheline, plutonic rock.

From the point of view of relationship of rock magmas this occurrence is extremely interesting, representing as it does a peculiar and rare rock type occurring some three thousand miles from the Montana region, but in a somewhat analogous position both as regards Tertiary age, and location some distance east of the main continental divide. It may be that other occurrences will be found in the future in the intervening region; the nearest representative to theralite known to me in the intermediate distance is the nepheline rock described by Zirkel (in the "Microscopical Petrography of the 40th Parallel") from Fortification Rampart, Elkhead Mts., Colorado, of which more will be said in the forthcoming monograph on the Crazy Mts.

The lack of a chemical analysis makes a comparison from the point of view of identity or difference of rock magmas of less value and weakens the argument which could be based on this occurrence against the localization of rock magmas, while on the other hand it points to a possible southern continuation of the zone of alkaline rocks occurring in the northwestern United States in the east border of the Rocky Mountains.

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