

been studied in great detail by Barrois, who distinguishes three successive zones in the metamorphic areola surrounding the granite. On the outside lies the zone of "goffered schists," in which a puckered structure has been developed without any new mineral combination of the elements of the rock. Next come the chiastolite-schists, with crystals of chiastolite, tourmaline, etc., which become more and more micaceous toward the interior, till they pass into the third and innermost zone, that of the leptinolites, which are highly micaceous schists with small crystals of chiastolite, and sometimes with tourmaline, rutile and triclinic felspar. Barrois also shows that round the masses of kersantite a ring of chloritic mica-schist has been developed, followed outside by one of spotted schists.<sup>29</sup>

Some important observations have been made by Barrois at Guéméné, in the maritime department of Morbihan, where Lower Silurian strata have been invaded by granite. Of special interest are the effects produced upon the sandstones (*grès à scolithes*), which are converted into micaceous quartzites. These altered rocks, traced further inward, are further distinguished by the development in them of sillimanite, sometimes in sufficient abundance to impart a foliated, undulated, gneissoid structure. At the contact with the eruptive rock, this quartzite shows recrystallized quartz, black mica, sillimanite, cordierite, and a good many crystals of orthoclase and plagioclase, besides white mica. The conglomerates show their matrix altered into a mass composed of rounded or angular grains of quartz united by abundant white sericitic mica, and containing some crystals of zircon, large plates of muscovite, and yellow granules of limonite.<sup>30</sup>

Another admirable locality for the study of contact-metamorphism is the eastern Vosges. Rosenbusch, in describing the phenomena there, has shown that the unaltered clay-slates are gray, brown, violet, or black, thinly fissile, here and there curved, crumpled, and crowded with kernels and strings of quartz.<sup>31</sup> Traced toward the granite of Barr Andlau, they present an increasingly pronounced metamorphism.

<sup>29</sup> "Recherches sur les Terrans anciens des Asturies et de la Galice," quarto, Lille, 1882.

<sup>30</sup> *Ann. Soc. Geol. Nord*, xi. 1884, p. 103. Compare also the early observation of Puillon-Boblaye regarding trilobites and orthids in chiastolite slates, *Comptes Rend.* vi. 1836, p. 168, confirmed by the Comte de Limur, *Bull. Soc. Geol. France* (3), xiii. 1885, p. 55.

<sup>31</sup> *N. Jahrb.* 1875, p. 849. "Die Steigerschiefer und ihre Contact-Zone," *Strassburg*, 1877. Unger, *N. Jahrb.* 1876, p. 785.