

crystalline minerals in ordinary sedimentary strata near the line of contact. The new minerals have usually an obvious affinity in composition with the original rock. But undoubtedly silica has often been introduced as part of the alteration, either free or as silicates. Moreover, a certain broad order of succession in the appearance of these new minerals may be observed in the larger areas of contact-metamorphism. On the outer margin of the ring or areole of metamorphism the internal rearrangements and mineralogical recombinations show themselves in many argillaceous rocks by the appearance of small knots or concretions which are replaced further inward by recognizable silicates, such as chiastolite, andalusite, staurolite, or kyanite, while toward the centre the dark mica which appears even in the outer parts of the ring attains a marked prominence, often accompanied with garnets and other new minerals.

A simple but interesting instance of this kind of contact-metamorphism was described many years ago by Henslow, near Plas Newydd, Anglesea. A basalt dike, 154 feet in breadth, there traverses strata of shale and argillaceous limestone, which are altered to a distance of 35 feet from the intrusive rocks, the limestone becoming granular and crystalline, and the shale being hardened, here and there porcellanized, while its shells (*Producti*, etc.), though nearly obliterated, are still traceable by their impressions. In the altered fossiliferous shale numerous crystals of analcime and garnet have been developed, the latter yielding as much as 20 per cent of lime.<sup>15</sup> Similar phenomena were observed by Sedgwick along the edges of intruded basalt among the Carboniferous limestones and shales of High Teesdale.<sup>16</sup>

In Hesse and Thuringerwald, Zirkel has described sandstones altered by contact with basalt, where the quartz-grains are enveloped in a vitreous matrix, in which abun-

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<sup>15</sup> Cambridge Phil. Trans. i. p. 402.

<sup>16</sup> Op. cit. ii. p. 175.