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ART. XXVI.—*On the Flexibility of Itacolumite*; by ORVILLE
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HAVING had many occasions for observing the extensive series of quartzose rocks known as itacolumite in the gold and diamond regions of Minas Geraes, Brazil, I have for some time entertained a suspicion that the peculiar property of flexibility would on investigation be found to be only a surface character. I have already shown (this Journal, vol. xxvi, p. 34) that much of the so-called itacolumite belongs to a higher geological horizon than that containing the flexible layers and that in the mountain of Itacolumi itself only a small part of the mass of the mountain is formed of the schistose beds of the lower series of quartzites in which alone, so far as I am aware, the property of flexibility has been observed. Even in the lower series flexible portions are rather uncommon, and the greater part of the mass is as rigid as any similar rocks.

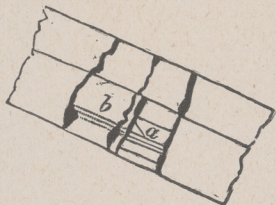
Artificial openings into this series of rocks are extremely rare, and so far itacolumite has been studied in its natural outcrops only at the surface, in which it is generally impossible to determine exactly how much the original characteristics of the rock have been modified by weathering. For some time past I have been on the lookout for an opportunity for studying unweathered itacolumite in order to determine whether or not the flexible layers extend beyond the action of surface agencies. Such an opportunity was recently afforded by the newly constructed Rio and Minas railroad. This line, starting

from the valley of the Parahyba, crosses the Mantiqueira division of the maritime range of mountains into the southern part of the province of Minas Geraes, and then follows the course of the Rio Verde, one of the headwaters of the Rio Grande branch of the Parana, in the mountainous plateau lying to the westward of the Mantiqueira. The cuttings are mainly through gneiss, in great part decomposed, but at several points narrow belts of itacolomite are also cut through. At a place called Jurumirim, the river and railroad pass by a short, narrow gorge through a high ridge of itacolomite extending from S.W. to N.E. In the sides of this gorge the rock is unusually well preserved and has been cut away to give passage to the railroad to within two or three meters of the drainage level. A few miles away to the northeast on the same ridge is the village of São Thomé das Lettras, famous for itacolomite quarries which have afforded beautiful flexible specimens. This locality is about fifty miles southwest of São João D'el Rei, a typical itacolomite locality, from which this formation has been traced continuously to and beyond the Serra de Itacolumi at Ouro Preto. Though the intervening region has never been examined, there can be little doubt that the beds here examined are identical and continuous with those of São João D'el Rei and Ouro Preto.

This cutting exposed very clearly the rock in its natural state and as affected by percolating waters and surface agencies. The total thickness of the itacolomite series in the range of hills is not far from 100 meters, of which about 40 meters near the center of the series are laid bare in the cutting. Of these 40 meters the upper portion is composed of massive beds from one to three meters in thickness, in which flexible portions are rarely found. In the lower part the beds are more schistose or flaggy, and divide readily into laminæ of a few millimeters to a few centimeters in thickness, the greater part of which are more or less flexible. In this portion, water percolates freely along the planes of stratification and lamination as well as along the numerous joints, and it is difficult to find masses that can with certainty be pronounced to be in their original state. The beds strike N. 60° E., and dip to the N.W. at an angle of 30°.

Among the heavy upper beds the action of the weather and of percolating waters has been less general and an opportunity of comparing weathered and unweathered portions is afforded. The beds are traversed by fissures, and in the masses separated by fissures and stratification planes, massive and schistose, compact and friable, non-flexible and flexible portions may be found within a distance of a few centimeters, and in exactly the same relative position in the bed. Several such masses were observed, of which one is represented in the following figure.

The block, *b a*, about two meters thick and separated by open fissures from its neighbors on either side, is traversed near the middle by three cracks. From between two of these cracks a prism-shaped mass had fallen out, leaving an open space. Water percolating through these cracks has opened several concealed planes of lamination in the right-hand portion (*a*); while to the left of the cracks, although these planes are clearly indicated by faint lines of color, the stone shows no signs of yielding along them, and fragments detached with the hammer at *b* do not break along the dotted lines more readily than in any other direction. At *b* the rock is exceedingly hard and not at all friable or flexible, while at *a* it divides readily into slabs two or three centimeters thick, crumbles to sand with the pressure of the fingers and is slightly flexible. It should be stated, however, that in preparing a microscopic slide from the rock at *b* the thin slice showed a considerable degree of flexibility, though perhaps not more than other granular rocks which are not at all flexible in masses may exhibit under the same circumstances. My experience in making slides is not sufficient to enable me to form an opinion on this point.



The property of flexibility is best seen in the thin plates into which the rock splits along the planes of lamination, that is to say, in the direction of the bedding. Owing to the difficulty of detaching pieces of suitable shape it is not so readily exhibited in other directions. At several points, however, where thin slabs or irregular prisms had been separated by fissures transverse to the bedding, it was also observed. The planes of stratification and lamination are thickly covered with silver-white mica, but in the massive portions of the rock this mineral is not at all prominent.

From these observations it may be concluded that flexibility is not an original characteristic of the rock, but that, like the opening of the planes of lamination and the development of friability in hard granular rocks, which it accompanies, it is a phase of weathering or of the decay brought about by percolating waters. So far as known, it is limited in Brazil to beds of a certain definite geological horizon, apparently of Huronian age. It would appear, however, that it might occur equally well in any fine-grained and thin-bedded or laminated quartzite or ordinary sandstone. Further examination will very probably show that it is not limited to rocks of any definite horizon or to any well characterized natural division of the quartzose rocks.