known. For the same reason the thickness of the phase can only be estimated. In various quarries the thickness of the exposed arkosic sandstone is up to 60 or 75 feet. The total thickness of the phase may be 125 feet in places.

The arkosic sandstone in thin section shows the chief mineral to be quartz. Most of the quartz grains are less rounded than in the true quartzite. The presence of arkosic material suggests that at least some of the quartz must have had little chance to become well rounded. Some secondary enlargement of the quartz grains has occurred, but there is also much sericitization in the binding material. The feldspars are remarkably fresh in thin section, being mainly microcline, soda microcline, and micropertithite. These minerals show some alteration to sericite. Euhedral grains of pyrite are disseminated through most specimens of the rock. A few grains of zircon are scattered through the sericitic matrix.

The arkosic sandstone that contains the *Scolithus linearis* horizon appears to be the same as the ordinary rock in respect to mineral content and microscopic appearance. The grains of opaque minerals are more numerous in the tubes than in the host rock, or vice versa. No other unusual microscopic characteristic is present.

**Jasper.**—Throughout Lehigh and Northampton Counties the Hardyston formation has local occurrences of jasper. Although the jasper is generally found as float, there is at least one locality, west of the Allentown-Philadelphia highway, south of Mountainville, Lehigh County, where it crops out as massive beds in the stratigraphic position of the Hardyston (pl. 15A).

The jasper of the Hardyston is taffy yellow to dark brown, or red. It is fine-grained, having a satin-like surface when very fine, and a fine sandy surface when coarse. The fracture varies from perfect conchoidal to rough. The rock is often a breccia which has been re-cemented by silica in the forms of chalcedony and quartz.

The jasper does not seem to occur at any definite horizon in the Hardyston, nor is it usually persistent for any great distance along the strike. One fact is generally true, namely, that the jasper phase is closely associated with the iron-ore phase. In nearly every old iron mine there are many blocks of jasper. The limonitic iron ore must be closely related to the jaspers in origin.

At several localities in Bucks, Berks, and Lehigh Counties, jasper pits were worked by the Indians, who there obtained their stone for weapons and implements. At Vera Cruz rather extensive openings were made. Large amounts of jasper chips are lying in the fields nearby, but few actual arrowheads or implements have been found. Presumably the Indians roughed out their weapons here, to make transportation easier. The fine dense jasper probably was very much sought for by the Indians, and the pits probably were carefully guarded by the tribes.

Myers ¹ and Fraser ² have made detailed microscopic examination of the jaspers of the region. The following paragraphs are quoted from Fraser's article: