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Stressed Quartzite for Silica Brick[1])

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About two years ago the writer introduced a research program at the Cerro de Pasco Laboratories in Oroya, Peru, with the aim of applying mineralogical principles to the solution of problems in silica brick manufacture. The purpose of the program was to improve the brick quality and lower the manufacturing and production costs. Improvement in the molding methods, the grinding and the particle size ratio, the burning time, the cooling rate, was attained. In addition, investigations concerned with the use of various "mineralizers" to give better conversion and the choice of raw material were undertaken. This note is a brief report on the results obtained in these two projects just mentioned.

The most severe difficulties during the manufacture of silica brick resulted from the high burning temperature and the long burning time. The kiln walls fell in frequently and the repair time on the kilns slowed production down seriously. Thus it was important to find a material which would convert at a lower temperature and in a shorter time. It was known from the literature that the addition of "mineralizers" would cause the quartz to convert faster and at a lower temperature. The following "mineralizers" were tried in two ways — with lime addition only and with lime and clay addition: sodium chloride, sodium carbonate, blast furnace flue dust, phosphorite, anhydrite, gypsum, titanium oxide, magnesia, reverberatory slag, coal dust. Best conversion and at the same time best strength were obtained with phosphorite and lime, and with reverberatory slag and lime with clay slurry. Fair results were also obtained from anhydrite with lime, gypsum with lime, titanium oxide with lime, magnesia with lime and clay. Sizing, molding, burning, etc. were exactly the same as for the usual bricks.

The next step, the search for the best raw material, yielded a result

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which has not yet been found reported in the literature. Conventionally, a quartzite raw material is analysed chemically and its suitability determined from the SiO_2, Al_2O_3, Fe_2O_3, $(Na, K)_2O$, TiO_2, CaO content. Some companies examine the quartzite microscopically, but only to determine grain size and mineralogic composition, sometimes instead of, but often in addition to the chemical analysis. A mica or chlorite matrix, or too much iron oxide, outlaws any quartzite raw material immediately.

To the knowledge of the writer, no attention has been paid so far to the actual manner of interlocking of the quartz grains, the intra- and the inter-granular nature. Quartzites with exactly the same chemical composition can show a large variance in regard to the nature of the quartz grains, their internal quality and the properties of their surfaces.

In the course of testing various quartzites for silica brick manufacture it was evident that the stressed quartzite from Chuquipita was superior. This quartzite has undergone inhomogenic folding and some shearing during Andean orogeny. Recrystallization has probably released some of the strain but later tectonic movements have continued to stress the quartz grains. Therefore the quartz grains and their surfaces are still under a strain. This is evident microscopically from undulating extinction. The lattice and the surfaces of strained quartz are unstable or active and tend to convert much more easily into tridymite and cristobalite than "sound quartz". — The results obtained from this raw material were superior to those obtained with the best "mineralizers". It is known that pure quartz from quartz veins (98,5—99,5% SiO_2) is not good material for brick making and this, I believe, is for the same reason: the quartz in veins is usually unstressed.

The result of this study suggests that mineralogic investigation can be of great value and should supplement chemical work during the evaluation of raw materials for silica brick.

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EXPLANATION OF PLATES I–III

Plate I: Fig. 1. Stressed quartzite from Chuquipita. Undulating extinction of most of the quartz grains shows the tectonic stress which rests on them. The grain size is very uniform and many boundaries interlacing. Crossed Nicols. Enlargement 150×.

Fig. 2. Poorly converted silica brick made from the old inhomogeneous, unstressed Huislamachay quartzite, also exhibiting poor sizing. Crossed Nicols. Enlargement 150×.

Plate II: Fig. 3. Largely converted silica brick. Some islands of "metastable quartz" ($N = 1.49—1.50$) have remained in a sea of minute cristobalite and tridymite crystals. Oroya silica brick made from Chuquipita quartzite (figure 1). Highest temperature reached: 1450° C, for about 20 hours. Crossed Nicols. Enlargement 150×.

Fig. 4. Completely converted silica brick from the Oroya brick yard (kiln No. 4 – August 1954). The exceptionally high temperature reached was 1500° C. The large "arrow heads" of tridymite twins as well as the needles and fish-scale cristobalite are clearly visible. Crossed Nicols. Enlargement 135×.

Plate III: Fig. 5. The northeastern limb of the quartzite anticline at Chuquipita, Central Peru (elevation: 4200 m). The quartzite is of Goyllar-Jatun age, and is underlain by metamorphosed limestone. At present the quartzite is mined at the top of the anticline, where it plunges below the surface.

Fig. 6. Flat laying quartzite layers, close to the top of the anticline, Chuquipita, Central Peru. Thick quartzite layers are separated by chloritic seams consisting of tuffaceous material which may have provided the free SiO_2 cementing the quartz grains of the quartzite. These Al_2O_3- and Fe_2O_3-rich seam have to be discarded during mining of high quality stressed quartzite.

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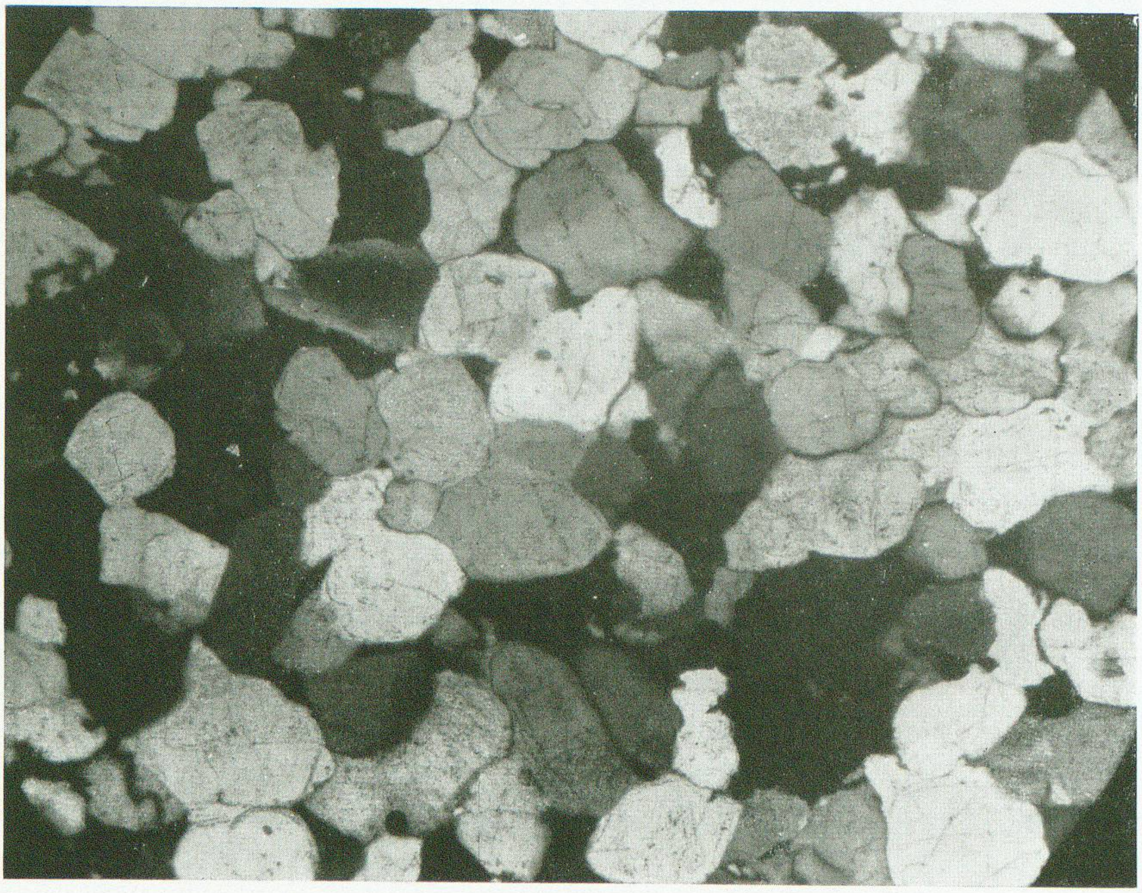

Fig. 1

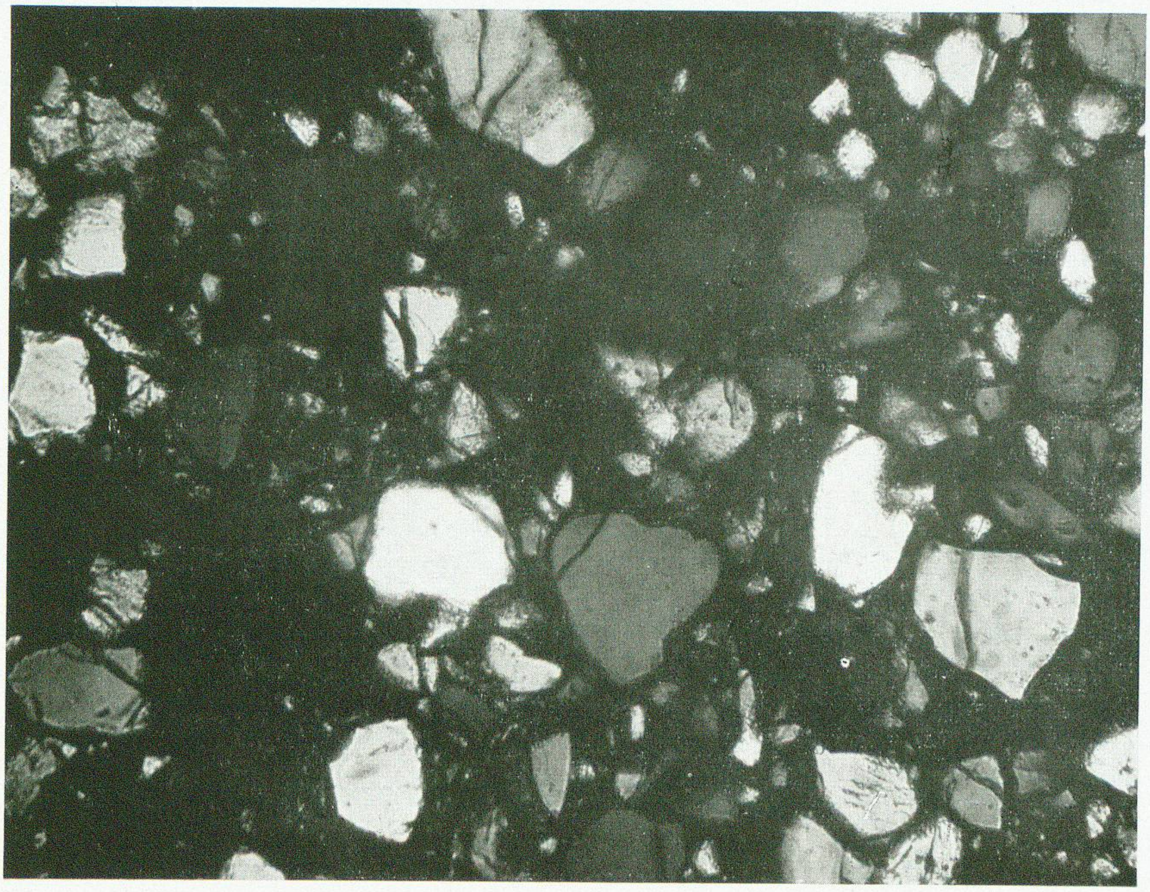

Fig. 2

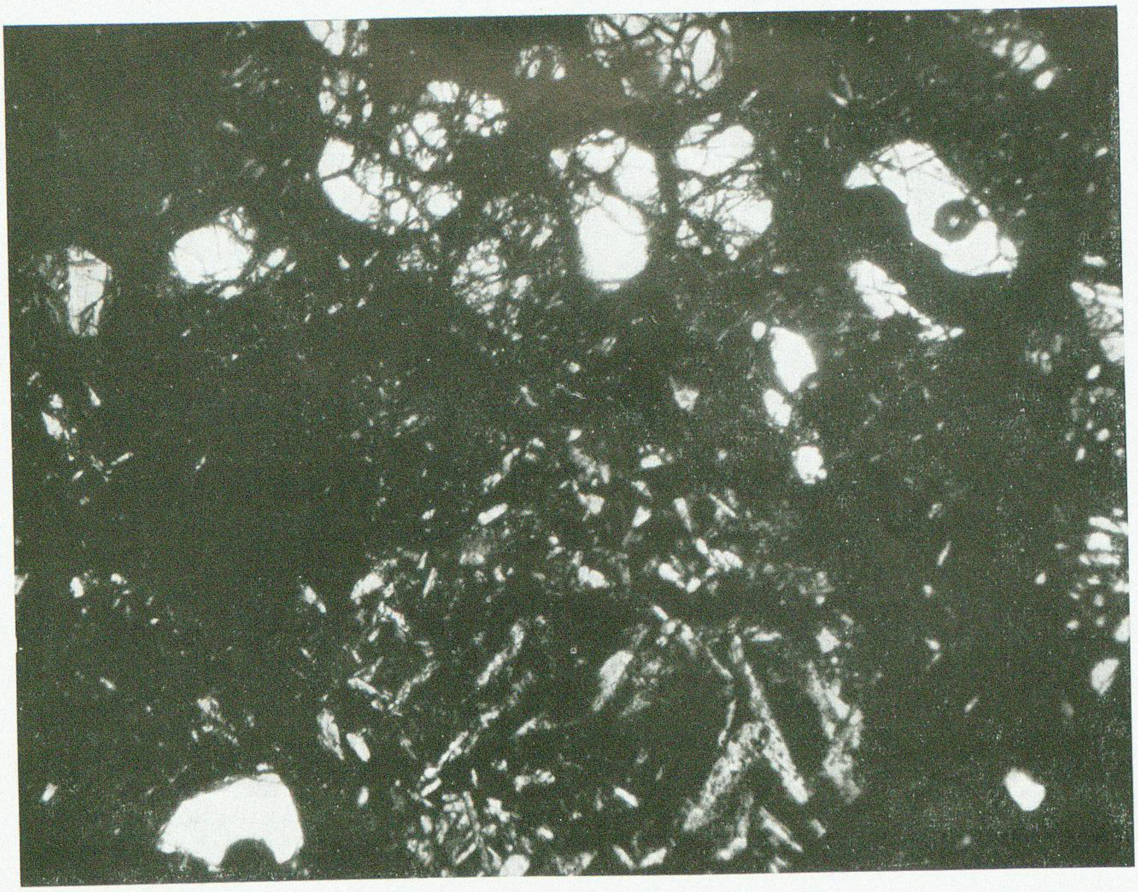

Fig. 3

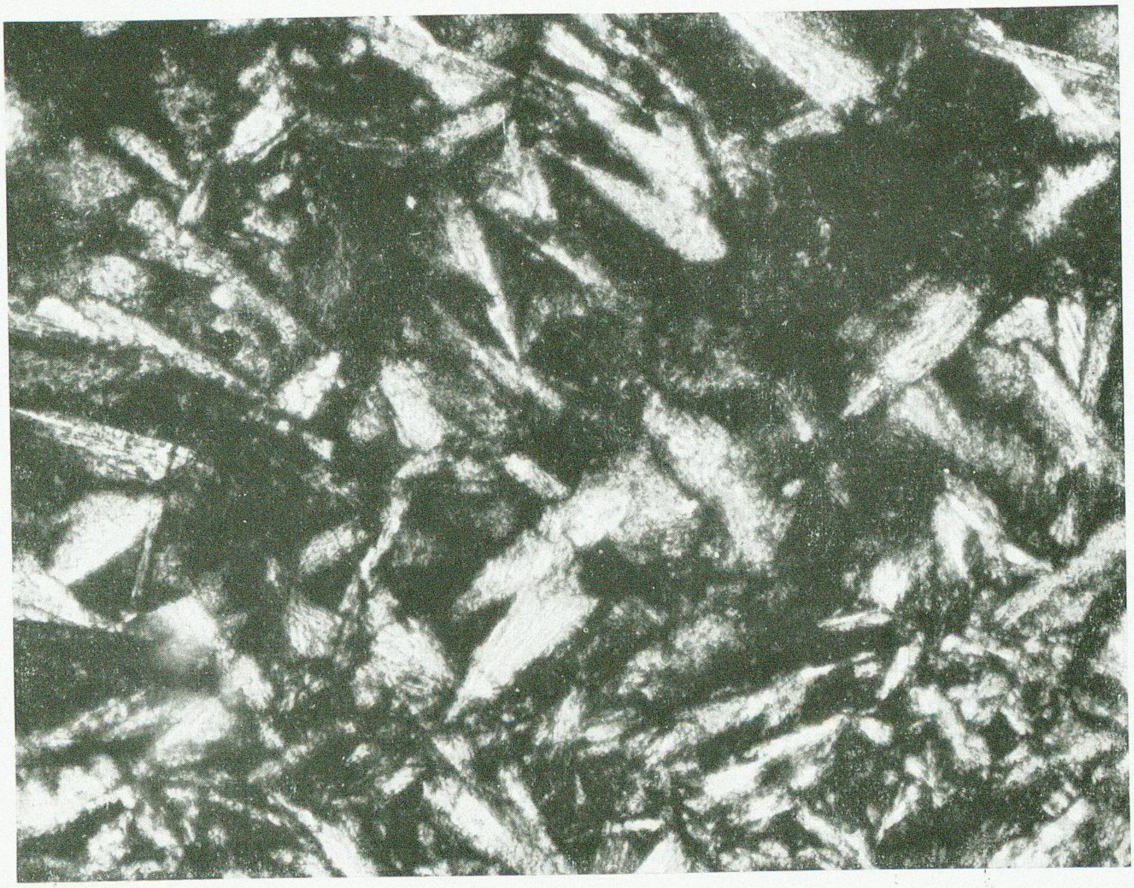

Fig. 4

PLATE III

Fig. 5

Fig. 6