

NOTES AND NEWS

OCCURRENCE OF CRISTOBALITE IN A SEDIMENTARY ROCK

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Some time ago, while investigating microscopically the rocks of Transcaucasia, we came across a very curious occurrence of Upper Tertiary argillaceous sandstone that contains a considerable quantity of cristobalite together with quartz. This specimen of sandstone was found in 1935 near the village of Nomanevi, in Western Georgia, near the contact with an overlying basalt. In general, cristobalite is not rare in sedimentary formations, and it has been listed many times as associated with such typically hydrochemical minerals as opal or montmorillonite.

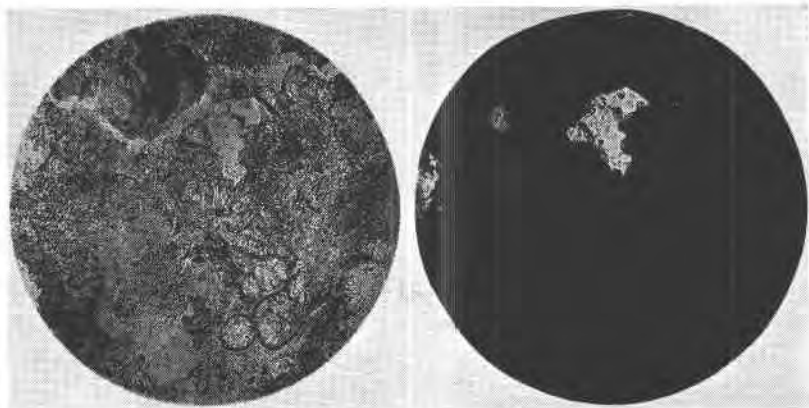


FIG. 1. Photomicrograph of a sandstone with quartz largely replaced by cristobalite. Remnants of quartz above center. $\times 100$.

FIG. 2. Same as Fig. 1. Crossed nicols. $\times 100$.

Therefore, it was not the cristobalite occurrence in the Nomanevi sedimentary rock that astonished us, but the mode of its occurrence in that rock, which indicated its secondary origin by means of a gradual cristobalitization of the primary quartz grains. This cristobalitization with an islet of preserved quartz is well seen in the photomicrographs Figs. 1 and 2.

We have briefly described this sandstone in our publication "Cristobalite in the Rocks of Caucasus and Transcaucasia" (in Russian, *Ac. of the U.S.S.R. Trans., Math. and natur. sc. section, geol. series*, 1936, No. 2-3, pp. 311-312). There we compared the cristobalitic regenera-

tion of quartz in the Nomanevi rock with similar regeneration of this mineral in the manufacture of silica brick, and during its use in a Martins metallurgical furnace. There the cement of the Nomanevi sandstone was described and the chemical analysis of the rock, which we repeat in Table 1, was given.

TABLE 1. CHEMICAL ANALYSIS (BY K. P. SOKOVA) OF THE NOMANEVI SANDSTONE (SAMPLE NO. 295)

| Composition | Percentage | Molec. ratios |
|--|------------|---------------|
| SiO ₂ | 60.14 | 1.002 |
| TiO ₂ | 0.88 | 0.011 |
| Al ₂ O ₃ | 15.55 | 0.152 |
| Fe ₂ O ₃ | 5.06 | 0.032 |
| FeO | 0.36 | 0.004 |
| CaO | 0.81 | 0.014 |
| MgO | 1.12 | 0.028 |
| MnO | 0.07 | 0.001 |
| BaO | 0.02 | — |
| K ₂ O | 0.78 | 0.009 |
| Na ₂ O | 0.27 | 0.005 |
| H ₂ O+ | 6.90 | 0.383 |
| H ₂ O- | 8.02 | 0.444 |
| Total | 99.98 | |

An examination of this analysis shows that, in addition to a very moderate percentage of SiO₂ for a sandstone, the Nomanevi rock is rather high in both Al₂O₃ (and Fe₂O₃) and H₂O, and that more than half of the latter is driven off below 110°C. The ratios of Al₂O₃ (and Fe₂O₃): H₂O correspond approximately to a ferric halloysite, in agreement with the microscopic properties of the argillaceous material in the rock, which is isotropic and has an index of refraction of $N = 1.549 \pm 0.005$. Larsen and Berman give in their tables¹ $N = 1.542$ for halloysite with the formula Al₂O₃·2SiO₂·*n*H₂O, $N = 1.554$ for halloysite with the formula Al₂O₃·2SiO₂·2H₂O. The Nomanevi halloysite has $n > 2$, as in Larsen's first example. Its high refraction (compared with $N = 1.542$) is caused probably by the presence of Fe₂O₃, and possibly by other oxides in solid solution or in the molecule of the mineral. The remaining oxides must be in some way distributed in those fine opaque particles which contaminate the argillaceous material. These particles are, in general, so finely dispersed that they give no possibility of an accurate microscopic

¹ Larsen, E. S., and Berman H., *The Microscopic Determination of the Nonopaque Minerals*, 2nd Edition, Washington, 1934, p. 51.

determination. Only in a few places they become large enough to permit a more or less distinct determination as fine plates of translucent hematite with red color.

The special peculiarity of the Nomanevi rock was the formation of cristobalite from quartz. The principal difficulty in explaining this lies in the fact that, according to modern conceptions based on Fenner's² experiments, quartz at relatively low temperatures up to 870° forms only one truly stable crystalline phase of anhydrous silica, which at these low temperatures is unable to undergo either direct tridymitization or cristobalitization. Therefore, for the interpretation of the peculiar Nomanevi paragenesis we have only the three following possibilities.

1. There was no actual direct alteration of quartz into cristobalite, but we have an intermediate regeneration of quartz under the influence of mineralizers with the formation of hydrosilicate gel or opal from which the metastable cristobalite crystallized normally, according to Ostwald's rule.

2. The direct alteration of quartz into cristobalite resulted from the contact effect of basaltic magma at temperatures higher than 870°; there also was a simultaneous dehydration of halloysite; further, on later decrease of temperature, there occurred a new hydration of halloysite.

3. The direct alteration of quartz into cristobalite took place at low temperatures in a medium rich in H₂O in the presence of halloysite.

The first of these possibilities appears to be excluded due to entire absence of any intermediate medium between the relics of quartz in the thin sections and the cristobalitic substance which surrounds them.

The third possibility is reasonable only on the assumption of insufficient data on Fenner's diagram, which on this theory would require additional experimental rechecking.

The second possibility appears to be the most probable of the three, but we have no evidence of its actual realization.

² Fenner, C. N., The stability relations of the silica minerals: *Am. Jour. Sc.*, 4th Ser., vol. 36, pp. 331-384, 1913.