AN ANALCITE SYENITE PORPHYRY FROM LING FÊNG HSIEN, SHANSI.

(With 1 plate)

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OCCURRENCE

In the district of Ling Feng Hsien (隰汾縣), formerly called Ping Yang Fu (平陽府), occurs a low hill near the village of Liang Chia Po (梁家坡), about 100 li east of the city or about 40 li to the east of Fou Shan Hsien city (浮山縣). The hill is formed by an Analcite Syenite-porphyry which occurs in the form of a round knob covering an area of about 150 sq. km. or being about 600 meters in the longest diameter. Surrounding the hill are Permo-Mesozoic red shales and sandstones.§ This hill is the terminal one among a series of low and high hills running N.E.—S.W. on the south-east and east of Ping Yang Fu (named from N. to S. there are T'a Shan 塔山, Shih Tsun Shan 十村山, etc. The highest one is about 150 m. above the village).

GENERAL APPEARANCE OF THE ROCK

The rock is very light flesh-red colored. Porphyritic texture is shown by a phanerocrystalline to cryptocrystalline ground-mass and the phenocrysts of white grey, prismatic crystals of feldspars having a length of 3 cm. to a few millimeters and minute prismatic crystals of amphibole. The latter is only sparingly distributed. The amount of phenocrysts does not play so dominant a part as that of the ground-mass; namely the rock is more or less dopatic according to the term of Iddings.

MICROSOPICC STUDY

Under microscope the ground-mass is of porphyroidal fabric, consisting of tabular crystals of millimeter sizes and minute laths.

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§ Geology of the region was mapped by my colleague Mr. C. C. Wang in 1922. The specimen under study was brought back by him. I should take this opportunity to express my thanks for his kind information.

Feldspars are the most preponderant constituent of the rock. Both basal and prismatic sections of *Orthoclase* forming phenocrysts are present. In the first kind, prismatic cleavage is clearly shown, while in the second Carlsbad partial penetration twinning is common. Some of the small phenocrysts may be anorthoclase as suggested by the rhombic shape of the sections, the very small extinction angle in the zone perpendicular to (010), and the faint twinning lamellæ.

Hypidiomorphic and prismatic sections of *Albite* twinned according to Carlsbad and Albite laws also occur as phenocrysts. The maximum extinction angle in the zone prependicular to (010) is—16 degrees. Prismatic cleavage is rather distinct.

Phenocrysts of Orthoclase are often seen to enclose minute crystals of albite and *Perthitic Orthoclase.*

Feldspar laths of the ground-mass are confined to *Orthoclase* which forms minute prismatic and untwinned crystals varying from 0.2 to 0.9 mm. in length and they are arranged more or less parallelly around the phenocrysts.

*Analcite** takes the second important part in the rock constitution. In hand-specimens it looks like colorless, transparent to translucent quartz in the form of minute grains. In thin sections under microscope it is entirely allotriomorphic and occurs in the angular interstices of the feldspars. The mineral sections are smooth and colorless. In a few cases two sets of fracture-lines are intersecting each other at more or less right angles. Under crossed nicols it is isotropic with a very slight optical anomaly. When treated with hydrochloric acid on an uncovered glass and left to slow evaporation, minute cubic crystals are developed. When it is treated with nitric acid, minute needlles crystalize out under ordinary room temperature and rhombic crystals

* The writer was at first mislead by the determinative method given by Dana & Winchell and reported without further confirmation the occurrence of the mineral, *Haüynite*, in the Third Annual Meeting of the Society. Upon receiving the information from Mr. Nyström through Dr. Wong that it is not a haüynite, the writer made a second experiment which result is here stated. I am glad to record here my obligation to Mr. Nyström for his kind information which enables me to make this correction before printing of the paper, and that his determination is fully confirmed by my later and more complete research. To my colleague Mr. H. T. Lee I should also express thanks for his collaboration in the experiment.

are formed upon slightly heating the slide. The cubic crystals are surely the salt (NaCl), while the needles and rhombic crystals may be gypsum according to the statement given by Dana & Winchell,[1] and may not be gypsum according to the method of detection given by Weinschenk & Johannson.[2] Then the mineral is extracted from the specimen and dissolved in hydrochloric acid, it gelatinizes, but yields no precipitates upon adding BaCl to the solution. Again dissolve the mineral in nitric acid and add BaCl to the solution, white heavy precipitates are formed. However they are readily dissolved upon addition of water. Evidently the white precipitates are not $BaSO_4$, but $Ba(NO_3)_2$. Therefore the rhombic crystals and probably the needles produced in the slide may be $NaNO_3$. The mineral is then heated by blowpipe. It fuses to a clear glass. Moreover it gives out water in a heated closed tube. By all tests the mineral is *Analcite*.

In the slides the analcite seldom occupies completely the interstices; but has broken into pieces. Probably some parts of the mineral are removed during grinding. The presence of several empty areas which are not seen in the specimen is quite probably due to this reason.

Femic minerals are very rare. Two generations of *Amphibole* can be recognized. Phenocrysts were formed in the first generation with a maximum length of about .5 cm. Both basal and prismatic sections are observed. Cleavages are distinct. Absorption colours are:—

Z.....deep green

X .....yellowish green or lighter green to greenish yellow.

Y.....between lighter green & greenish yellow.

The maximum extinction angle (Z ∧ c) is 64°. Elongation is (—). It seems to be a *sodic Amphibole* probably resembling *Katoforite*.

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1) *Dana's* Text Book of Min., 1922 edition, pp. 502–03. *N. H. Winchell:*—Elements of Optical Min., 1909, p. 365.

2) *Weinschenk's* Petrographic Methods translated by *Clark*, p. 223, also Petrog. Methods by *A. Johannson*, pp. 563–64 and the references there given.

3) *Pennfield & Brush;*—Determinative Min. p. 122.

The amphibole of the second generation consists of minute crystals, most of which occur along the edges of the interstices filled by Analcite, and some of them are even included by the latter. They are idiomorphic or hypidiomorphic. Color of absorption is greenish yellow though pleocroism is weak. Cleavages on the basal sections are observed. Elongation is (—) and the maximum extinction angle (Z ∧ c) in the prismatic section is 45°. It may be also a soda-bearing amphibole having the similar composition as *Katoforite*. Besides the above-mentioned minerals, *Ilmenite*, *Zircon*, and *Apatite* are present, but they are accessory elements. In a few cases the apatite and ilmenite are well included by the soda-bearing amphibole.

MINERALOGICAL AND CHEMICAL† PERCENTAGES

Minerals	*% in volume*	*% in weight*
Orthoclase	83.90	87.81
Albite	3.90	4.16
Analcite	3.83	3.54
Sodic Amphibole††	1.46	2.07
Ilmenite	0.76	1.40
Zircon	0.50	0.96
Apatite	0.04	0.05
	94.39	99.99

SiO_2	62.85
Al_2O_3	17.88
Fe_2O_3	0.19
FeO	1.15
MgO	0.05
CaO	0.13
Na_2O	1.12
K_2O	14.82
P_2O_5	0.02
TiO_2	0.80

† Calculated from the mineralogical composition.
†† All the sodic Amphiboles are calculated according to the comp. of Katoforite given in the "Rock-forming minerals", by Iddings.

ZrO_2	0.66
H_2O	0.29
F or Cl	trace
	99.96

Although it is not an actual chemical analysis, it shows well that the composition is one of syenite. The only difference is that Al_2O_3 is a little higher and K_2O wonderfully high. The last character is no doubt due to the large amount of *Orthoclase* in the rock, though K_2O may be a little overestimated because the anorthoclase has been calculated together with the orthoclase since it is impossible to distinguish every small section in the slide before counting the volume percentage.

The composition does not look like one of the ordinary alkalic rocks, but the large amount of K_2O indicates that the rock is alkalic. Therefore it is reasonable to have the presence of the mineral, Analcite, which is often present in alkaline rocks.

HISTORY OF THE ROCK

Probably during the middle Mesozoic era and most probably contemporaneous with the intrusion and eruption of the Tzu Chin Shan Alkali-Syenite in W. Shansi,† the magma of the Analcite syenite-porphyry was intruded into the Permo-Mesozoic formations under the hypabyssal condition and solidified in the following order of crystallization:—

Iron oxide ———————

Apatite ———————

Zircon ———————

Albite ———————

Orthoclase ———————

Amphibole ———————

Analcite ———————

† *Norin:*—Tzu Chin Shan Alkali-Syenite, Bull. Geo. Surv. China, No. 3, pp. 45–70.

Later the rock is subjected to slight alteration by which the orthoclase of the ground-mass and the albite phenocrysts are slightly changed into kaolinic matter along cleavages, while a few phenocrysts of orthoclase stand rather unaltered. Amphiboles are all fresh. However some iron oxide is altered to *Leucoxene*.

CONCLUSION

Analcite is commonly known to be a secondary mineral. However in the present case the perfect freshness and limpidity of the mineral and its definitely interstitial position suggest the primary origin. It may be formed at the end-stage of crystallization of the magma in which vapors are held under pressure.

Analogous occurrences of Analcite have been found in Sodalite-syenite,[1] Nephelite-Syenite,[2] and Phonolite;[3] but probably the most similar occurrence is the Analcite-Syenite found at Howford Bridge, near Mauchline, Ayrshire.[4] In that case Analcite is very conspicuous and no feldspathoids occur together in the same rock. Prof. Tyrrell also considered the mineral to be of pyrogenic origin.

1) *W. Lindgren:*—A Sodalite Syenite.....from Montana, Am. Jou. Sci. 1893, p. 286.
2) *L. V. Pirsson:*—Petrg. of the Ign. Rocks of the Little Belt Mt., Ann. Rep. U. S. G. S. 20, 1898-99, p. 469.
3) *W. Cross:*—Geology of the Cripple Creek Dist., Colorado, U. S. G. S. Ann. Rept. 1894-95, p. 38.
4) *G. W. Tyrrell:*—Alkaline Igneous Rocks, W. Scotland, Geol. Mag., London, 1912, pp. 70-78.

A

B

A. Showing the porphyritic character of the rock (crossed nicols). Phenocrysts of albite, orthoclase, and amphibole are represented. (×80)

B. Showing the phenocrysts of amphibole and the interstitial Analcite and Amphibole of the second generation. Hy refers to Analcite. (×80)