MINERALOGICAL NOTES

PREHNITE FROM THE CONTACT METAMORPHIC AUREOLE OF THE WHIN SILL INTRUSION, NORTHERN ENGLAND

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Abstract

Prehnite is recorded for the first time from the contact aureole of the Whin Sill intrusion in Teesdale, northern England. An electron microprobe study of the prehnite has shown an overall range of Fe2O3 (total iron) from below the detection limit to 8.3 percent and from 0.3 to 7.0 percent within an individual crystal. Substitution of Fe3+ for Al extends, therefore, to over 21 mole percent. Optical properties are given for the two most iron-rich crystals.

Introduction

Prehnite has been well documented from low-grade regional metamorphic regimes but data available for material from contact metamorphic areas appears to be minimal. Prehnite has been recorded for the first time during the present investigation in a number of samples from the contact aureole of the Whin Sill, a quartz–dolerite intrusion of late Carboniferous age. The sill is intruded mainly into Lower Carboniferous sediments consisting dominantly of limestone with sandstone and shale horizons (Dunham, 1948). The prehnite is found in the impure limestones and calcareous shales, up to 5.5 m from the upper contact of the sill, which is 73 m thick in the area of study.

Optical Properties and Chemistry

The prehnite occurs commonly as xenoblastic crystals forming the matrix to small (0.5 mm) pockets and lenses, which are surrounded by and embedded with sub–idioblastic grossular. A characteristic feature of the prehnite is its undulose extinction, with crystals displaying anomalous first order blue interference colors. Most of the crystals showing these optical anomalies have fine twin lamellae present.

Partial electron microprobe analyses have been undertaken following the techniques of Sweatman and Long (1969), the raw data being processed using the programme EMIADR (Ruckle and Gasparini, 1969). The recalculated CaO, Al2O3 and Fe2O3 (total iron) values of twelve analyses of four crystals, in three samples are shown in Figure 1. A substantial departure from the ideal composition of prehnite, [Ca2Al2Si3O10(OH)2], shown by the arrow on the CaO–Al2O3 join in Figure 1, is indicated by the CaO:Al2O3:Fe2O3 ratio of 48.7:36.0:15.3 in an analysis from sample 43/3 (Fig. 1). A large variation is also seen within a single crystal from sample 35/4, the CaO:Al2O3:Fe2O3 ratios varying from 53.1:46.3:0.6 to 50.0:36.6:13.4 (Fig. 1).

Assuming total iron as ferric and (OH) as 4.00, the atomic proportions of some of the analyses have been recalculated on the basis of twenty–two oxygen equivalents. Based on the above assumptions the analysis showing the highest Fe2O3 content (8.3 per-

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cent) represents over 21 percent substitution of Fe** for Al in the series Ca₂Al₂Si₅O₁₀(OH)₂–
Ca₂Fe₂Si₅O₁₀(OH)₂. The average analyses of the two most iron–rich crystals (Table 1A) show be-
tween 16 and 18 percent substitution of Fe** for Al (Table 1B).

The extent of Fe** ⇆ Al substitution recorded in the present study is much larger than recorded by
Hasimoto (1964), who suggested that less than 10 percent substitution is usually found in natural
prehnites. The Fe₂O₃ values recorded here are similar to those recorded by Surdam (1969) for prehnite
from a low-grade regional metamorphic environment. He recorded a maximum average Fe₂O₃ con-
tent of 8.2 percent, while his most iron–rich analysis was indicative of some 30 percent Fe** ⇆ Al sub-
stitution.

The optical properties of the two crystals analyzed from sample 43/3 are given in Table 1C. The
refractive indices, which show a small increase with increase of iron substitution, correspond reasonably
with the calibration curves given by Hasimoto (1964) for the variation in refractive indices of prehnite with
iron substitution.

As relatively few analyses are available, no particular variation in composition of the prehnite can be
correlated with distance from the intrusive contact.
It is worthy to note, however, that eight of the ten point analyses from samples 35/4 and 43/3, within
0.1 m of the contact, show appreciable substitution, while the two analyses of sample 44/11, 5.5 m from
the contact, show virtually no substitution (Fig. 1).

Acknowledgments

G. Rowbotham is thanked for critically reviewing the manuscript. The work was supported by a Nature Con-
servancy of Great Britain Award (N.E.R.C. Research Studentship).

References

DUNHAM, K. C. (1948) Geology of the northern Pennine
RUCKLIDGE, J., AND E. L. GASPARRINI (1969) EMPADR VII
Specifications of a computer program for processing elec-
tron microprobe analytical data. Dept. Geology, Univer-
sity of Toronto, Canada.
SURDAM, R. C. (1969) Electron microprobe study of preh-
nite and pumpellyite from the Karmutsen Group, Van-
couver Island, British Columbia. Amer. Mineral. 54,
256–266.
SWEETMAN, T. R. AND J. V. P. LONG (1969) Quantitative
electron probe microanalysis of rock–forming minerals.
J. Petrology, 10, 332–379.