it is impossible to reproduce the color on heat decolorized specimens, or to strengthen the color, by means of strong radium preparations. In every case the color so obtained was that of smoky quartz. The analyses show that the color can not be due to compounds of Ti or Fe, or to hydrocarbons. Ti is accounted for by the universally present rutile inclusions, and Fe is derived chiefly from limonite stains. But Mn varies regularly in amount with the depth of color, and there are no inclusions to which it is due. Rose quartz is decolorized in air near 575°C., and if formed above that temperature quartz will be white even though it may contain enough manganese to have colored it at a lower temperature. The absorption spectrum agrees with that of Mn''' glasses and solutions. Its pleochroism is exactly like that of other minerals which owe their color to Mn'''. The loss of color on heating is accounted for by a change in the valence of the manganese. Rose quartz was very closely simulated in amorphous hydrated silica, colored by only 0.01% MnO. This silica gel was even more easily decolorized by heat than was the natural rose quartz.

There is, therefore, a strong convergence of different lines of evidence leading to the conclusion that rose quartz owes its color to the presence of trivalent manganese.

THE PROPERTIES OF SCAPOLITE

A. N. Winchell, *University of Wisconsin*

The chief constituent molecules of scapolite were first recognized by Tschermak[1] fifty years ago. This made it possible for Lacroix[2] to show that, in general, the refringence and birefringence increase with increase of calcium. About fifteen years ago Himmelbauer[3] investigated the matter in more detail and prepared diagrams showing the relations between variations in composition and in the length of the vertical axis, the specific gravity, the refringence and the birefringence. He assumed rectilinear variations in all cases. Discrepancies were not small in all cases, but were attributed to impurities.

---

[1] *Sitz. Akad. Wiss. Wien.*, **LXXXVIII, I,** 1154, (1883).

[2] *Bull. Soc. Fr. Min.*, **XII,** 356, (1889).

[3] *Sitz. Akad. Wiss. Wien.*, **CXIX, I,** (1910).

About ten years ago Borgström[4] laid the foundation for more accurate work by showing that the molecules proposed by Tschermak are not the only ones concerned in the composition of scapolite, and that one of Tschermak's molecules is probably not exactly correct. Recently, Sundius[5] has shown that two of Borgström's molecules need slight corrections, while Goldschmidt[6] has emphasized the importance of potassium in scapolite and Shannon[7] has shown that fluorine may be abundant. Accordingly, the present status of knowledge regarding the composition of scapolite may be summarized as follows; the chief constituents are: $NaCl \cdot 3NaAlSi_3O_8$ and $CaCO_3 \cdot 3CaAl_2Si_2O_8$.

However, the following molecules are also present, sometimes in important amounts: $NaHCO_3 \cdot 3NaAlSi_3O_8$, $NaHSO_4 \cdot 3NaAlSi_3O_8$, and $CaSO_4 \cdot CaAl_2Si_2O_8$. $KHCO_3 \cdot 3NaAlSi_3O_8$ is not uncommon in small amounts and in rare cases it is important; K may probably replace part of Na in other molecules, also. Finally, in one case, fluorine seems to replace all other acids (except silicic) in meionite in the molecule $CaF_2 \cdot 3CaAl_2Si_2O_8$.

This new and more accurate information regarding the constituent molecules of scapolite has apparently stimulated research regarding the exact relations between variation in composition and variations in physical, and especially optical, characters. In the short time since Borgström's paper appeared some eighteen different scapolite crystals have been studied both chemically and optically, and these studies have been of an accuracy such that earlier data, including the results of Himmelbauer, must be rejected as no longer important, except in the historical sense.

A summary of the new data is presented graphically in Fig. 1. Sundius[8] prepared diagrams of this general character, but he always used the function $\frac{N_o+N_e}{2}$, instead of the indices separately. A more accurate value of the mean index would be derived from $\sqrt[3]{N_o^2 \times N_e}$. The index most easily used in microscopic work is N_o, rather than any mean value; therefore, a diagram

---

[4] *Zeit. Kryst.*, **LIV**, 238, (1915).

[5] *Bull. Geol. Inst. Upsala*, **XV**, 1, (1916), also **XVI**, 96, (1918).

[6] *Die Kontaktmetamorphose im Kristianagebiet*, 315, (**1911**).

[7] *Proc. U. S. Nat. Mus.*, **LVIII**, 481, (1920).

[8] Geol. Kirunagebiete. 4. *Veten. prak. undersök. Lappland, Kirunavaara Aktieb.* 195, (1915); see also his other articles, already cited.

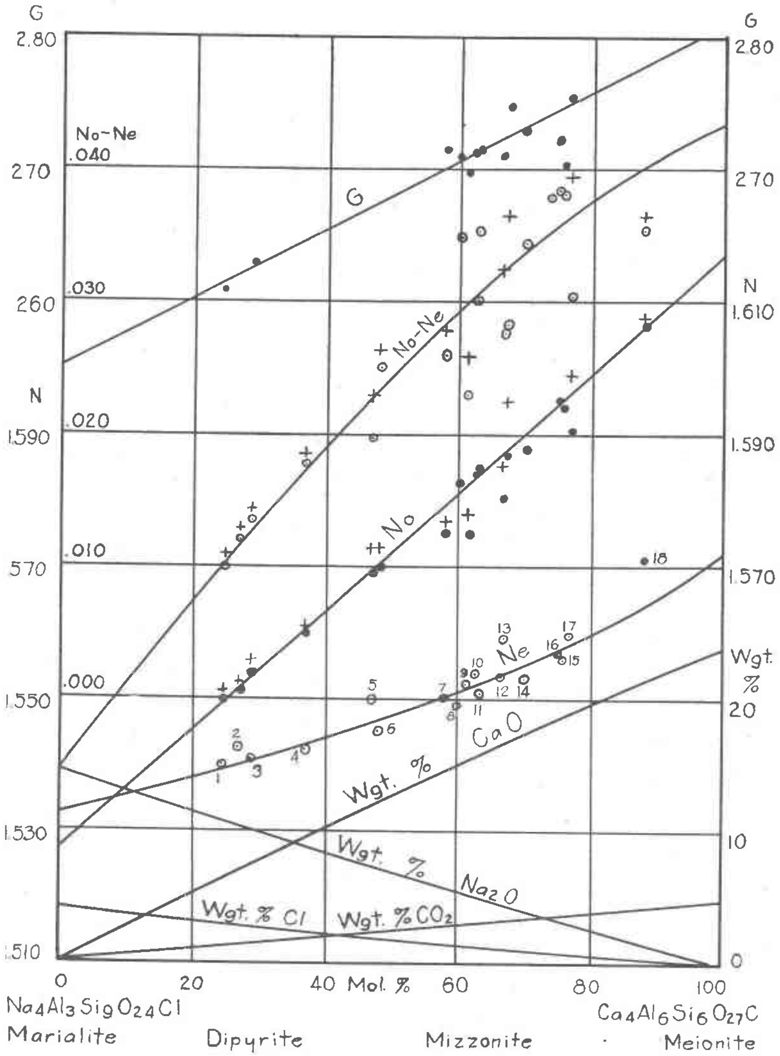

Fig. 1. Relations between composition and physical characters in scapolite. Recorded data indicated by dots and circles; data corrected for other than the chief molecules indicated by crosses—these are above the preceding in all cases.

showing this value separately should be of service. Moreover, the new diagram brings out some unexpected features. After entering all available data, first as given (shown by • and ⊙), and then as corrected (shown by +), so far as possible, to make proper allowance for the presence of other molecules besides those on which the diagram is based, it appears that straight lines are satisfactory to show the variations in specific gravity and in the ordinary index (N_o), but they are not satisfactory for the extraordinary index (N_e) nor for the birefringence. Further, the data indicate that pure marialite would be positive, while a crystal of composition about $Ma_{90}Me_{10}$ would be isotropic.

Curves are included in the diagram to show the tenor of Na_2O, CaO, Cl and CO_2 by weight, since some calculation is necessary to obtain them from the molecular composition.

The name wernerite is not included as a subspecies of scapolite since current practice seems to make it synonymous with scapolite as a name for the entire series. The divisions of the series are made at simple decimal ratios.

The diagram is intended to apply to the main series only, namely, $NaCl \cdot 3NaAlSi_3O_8$ to $CaCO_3 \cdot 3CaAl_2Si_2O_8$. Data are not yet sufficient to permit the preparation of a graph for the other series, but it may be said that the sulphate radical seems to cause a decrease in the birefringence by lowering N_o about .004 for each weight per cent of SO_3, and it may be inferred from the single carefully studied sample[9] high in potassa (and water) that these lower the refringence without materially changing the birefringence.

Two comments regarding the relations between composition, space lattices and symmetry in this series seem worthy of record.

First, since chlorine belongs to the oxygen space lattice and CO_3 and SO_4 may take the place of chlorine, the latter groups may substitute (in limited amount) for one oxygen atom without making the crystal unstable, the stability probably depending primarily upon the space lattice of the much larger non-oxygen atoms (Si, Al, Ca and Na).

Second, the radical difference in symmetry between plagioclase and scapolite is perhaps due to the fact that the molecule of the former consists of 5 non-oxygen atoms (or some multiple thereof), while the molecule of scapolite consists of 16 atoms (omitting

[9] V. M. Goldschmidt: *Vid. Skr. I, Mat. Kl.*, **No. 1,** (1911).

O, Cl, etc.), of which 4 are sodium or calcium, and the others are the nearly equivalent Al and Si atoms.

REFERENCES FOR SCAPOLITE SERIES

1. Kalpivaara, Sweden. N. Sundius: Geologie des Kirunagebietes. 4 *Veten. prakt. undersök. Lappl. Aktebolag*, 214, (1915).
2. Olsbo, Norway. N. Sundius: *Bull. Geol. Inst. Upsala*, **XV**, 1, (1916).
3. Pahtosvaara, Kiruna, Sweden. N. Sundius: *loc. cit.*, **No. 1.**
4. Enterprise, Ont. L. M. Borgström: *Zeit. Kryst.*, **LIV**, 238, (1915).
5. Haliburton, Ont., L. M. Borgström: *loc. cit.*
6. Kanda river, Siberia. O. O. Baklund: *Bull. Acad. Imp. Sci. Petrograd*, **XI, 1**, 19, (1917). *Min. Absts.* II, 126, (1923).
7. Vahaive, Kiruna, Sweden. N. Sundius: *loc. cit.*, **No. 1.**
8. Waldviertel, Austria. N. Sundius: *loc. cit.*, **No. 2.**
9. Nautanen, Sweden. N. Sundius: *Bull. Geol. Inst. Upsala*, **XVI**, 96, (1918).
10. Mansjö Mt., Sweden, in pegmatite. H. Eckerman: *Geol. För. Förh. Stockholm*, **XLIV**, 367, (1922).
11. Gulatal, Norway. N. Sundius: *loc. cit.*, **No. 8.**
12. Laurinkari, Finland. L. M. Borgström: *loc. cit.*
13. Laachersee, Eifel. R. Brauns: *N. Jahrb. Min. B. B.*, **XXXIX**, 79, (1914); and *N. Jahrb. Min.*, **I**, 9, (1917). CO_2 corrected by N. Sundius: *loc. cit.*, **No. 8.**
14. Hesselkulla, Sweden: N. Sundius: *loc. cit.*, **No. 2.**
15. Ersby, Pargas, Finland. L. M. Borgström: *loc. cit.*
16. Mansjö Mt., Sweden, in contact zone. H. Eckerman: *loc. cit.*
17. Laachersee, Eifel. R. Brauns: *loc. cit.*, CO_2 corrected by N. Sundius: *loc. cit.*, **No. 8.**
18. Vesuvius, Italy. L. M. Borgström: *loc. cit.*

QUARTZ IN METEORIC STONES

GEORGE P. MERRILL, *U. S. National Museum*

Nearly every detailed analysis of meteoric irons shows traces of silica, which, if reliance can be placed on the examination of the insoluble residues, occurs in the form of minute quartz granules and sometimes distinct crystals. The manner in which these residues have been obtained, it must be confessed, throws a doubt on some of the determinations but the occurrence noted below in the St. Mark's, South African stone, at least insures their possible correctness.

Silica in the form of tridymite (asmanite) it will be remembered constitutes 8.527% of the pallasite of Steinbach, and Berwerth of Vienna has described both quartz and tridymite in the stones of Juvinas, Stannern, Jonzac and Peramho, which he believed to be secondary and due to the breaking down of the pyroxenic