

Minrecordite

a new mineral from Tsumeb

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ABSTRACT

Minrecordite is the Ca and Zn member of the dolomite series, $\text{CaZn}(\text{CO}_3)_2$, with an ordered arrangement of cations and belonging to space group $R\bar{3}$. It was found on a unique diopside specimen from Tsumeb, Namibia, which came from the second oxidation zone, presumably at the 30–32 level. The mineral forms minute, twisted, pearly, lustrous rhombohedrons up to about 0.5 mm. They grew following a first generation of large diopside crystals, and before a second generation characterized by more minute and morphologically complex individuals.

Two distinct variants of minrecordite have been identified. **Type A** represents nearly pure $\text{CaZn}(\text{CO}_3)_2$, with only a minor substitution of Mg, Fe, and Mn for Zn. It has $a = 4.8183(4)$, $c = 16.0295(10)\text{\AA}$. Measured specific gravity is 3.45(2); calculated density is 3.445 g/cm^3 . The indices of refraction are $\omega = 1.750(2)$, $\epsilon = 1.550(2)$. **Type B** is a magnesian variety. Its unit-cell parameters are larger; specific gravity and indices of refraction are lower. Its deposition is apparently earlier than that of pure minrecordite.

On several diopside druses from Tsumeb a mineral occurs, quite similar in appearance to minrecordite, and occupying the same position in the paragenetic sequence. This mineral can be easily confused visually with minrecordite itself, but analyses show it to be merely a zincian variety of dolomite.

The mineral and its name were approved by the I.M.A. Commission in February 1981. It is named from *Mineralogical Record*, a worthy magazine in promoting both a better knowledge of Tsumeb minerals and a more beneficial interaction between professional and amateur mineralogists. The holotype specimen of minrecordite is in the Museum of the Institute of Mineralogy, Bari (Italy) University.

INTRODUCTION

In 1967 one of us (G. Fioravanti) obtained in exchange, from a Johannesburg collector, several specimens of crystallized diopside from Tsumeb. One specimen, about $5 \times 5 \times 6\text{ cm}$, exhibited, scattered on diopside, a number of microcrystals of a white mineral. These were provisionally labeled "willemite," perhaps on the basis of its high Zn content as revealed by some qualitative chemical tests.

Some years later, a more accurate re-examination of this specimen showed that the white mineral forms very small, strongly twisted rhombohedral crystals, quite dissimilar in their morphology from any known willemite crystals. Moreover, the occurrence of

younger willemite on diopside seemed in disagreement with the paragenetic sequences of Tsumeb secondary minerals, as described by Keller (1977). For these reasons, the specimen was submitted to the attention of the Institute of Mineralogy of Bari University, in order to establish the true identity of the minute white crystals.

As a result of this detailed study, we became convinced that we were dealing with a new mineral species, of ideal composition $\text{CaZn}(\text{CO}_3)_2$, corresponding to a new member of the dolomite series. For this new mineral we have proposed the name *minrecordite*. This name is in honor of the magazine the *Mineralogical Record*, which is especially worthy as an active promoter of a better knowledge of Tsumeb minerals. Moreover, this mineral has been found as a result of collaboration between professional mineralogists and a collector. Thus the name seems particularly appropriate owing to the worldwide success of the *Mineralogical Record* in bridging the gap between professional and amateur mineralogists.

The new mineral and its name were approved by the I.M.A. Commission on New Minerals and Mineral Names in February 1981.



Figure 1. A moderately twisted, milky white mosaic rhombohedron of minrecordite measuring 0.075 mm on edge. Fioravanti specimen.

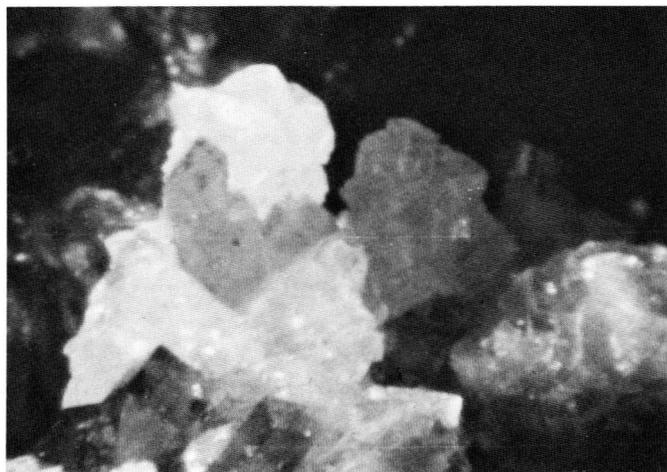


Figure 2. A milky white cluster of minrecordite about 0.7 mm across at the base. A diopside (II) crystal is perched on the cluster, and a darker cluster of magnesian minrecordite is present behind and to the right. Fioravanti specimen.

The original minrecordite-bearing single specimen was subsequently divided into several fragments (only three of which still exist) for mineralogical studies. A piece (designated as the holotype) is now deposited in the mineral collection of the Institute of Mineralogy of Bari University, numbered HO-4/81. Cotypes are in the private collections of G. Fioravanti (Rome) and C. L. Garavelli (Bari).

DESCRIPTION and PARAGENESIS

The matrix of the minrecordite-bearing specimen is reddish, massive and partly earthy or ocherous. It has the well-known appearance of diopside specimens from the second Tsumeb oxidation zone, at the 30–32 levels; the only distinctive feature is the complete lack of country rock (gray dolostone) usually present in the matrix of diopside druses from Tsumeb. The reddish matrix is rich in small masses and veins of milky white crystals, mostly anhedral and only occasionally (on the inside of small vugs) in the form of well-shaped minute rhombs. These crystals are a zincian variety of dolomite, admixed with spathic calcite. As a rule, they include or are partly coated with very fine-grained, light green duftite and much smaller amounts of malachite needles. A thin layer of this material can also be observed between the matrix and the large diopside crystals.

The malachite crystals range from about 10 to 15 mm in length. They are lustrous, semitransparent, dark emerald-green, and are partly strewn with minute minrecordite crystals.

Minrecordite occurs as two variants which are visually distinguishable from each other:

Type A (generally referred to here simply as minrecordite or “pure” minrecordite, with the understanding that “pure” is used as a relative term): Rhombohedral microcrystals up to about 0.5 mm, which are very markedly saddle-shaped, milky white in color and with a typical very strong pearly luster.

Type B (generally referred to here as “magnesian” minrecordite): More regular and less twisted rhombohedral microcrystals. As a rule, they are almost completely transparent, glassy and colorless; typically they nest at the bases of small hemispherical aggregates, which are composed principally of pure minrecordite (but see addendum).

Magnesian minrecordite crystals are smaller (0.2 mm as the maximum rhomb edge) and by far scarcer than pure minrecordite. They typically include a very fine-grained, reddish ocherous pigment; occasionally they are intimately admixed with cerussite and calcite.

As will be shown below, these two minrecordite variants differ

Table 1. Indexed powder patterns for minrecordite (Diffractometer, Cu K α filtered radiation, step-scanning at 0.01° 2 θ steps and 2·10⁴ fixed counts).

			Minrecordite			Magnesian Minrecordite		
h	k	l	d _{calc.} (Å)	d _{obs.} (Å)	I	d _{calc.} (Å)	d _{obs.} (Å)	I
1	0	1	4.038	4.039	10			
0	1	2	3.7012	3.7008	20	3.7171	3.7180	20
1	0	4	2.8903	2.8896	100	2.9059	2.9056	100
0	0	6	2.6716	2.6723	3			
0	1	5	2.5422	2.5418	3	2.5569	2.5569	< 1
1	1	0	2.4091	2.4095	25	2.4177	2.4176	20
1	1	3	2.1962	2.1965	20	2.2054	2.2060	25
0	2	1	2.0689	2.0685	3			
2	0	2	2.0191	2.0192	15	2.0267	2.0266	2
0	2	4	1.8506	1.8506	10	1.8586	1.8578	10
0	1	8	1.8062	1.8064	33	1.8179	1.8180	35
1	1	6	1.7891	1.7889	40	1.7983	1.7990	35
2	1	1	1.5696	1.5696	5	1.5752	1.5757	3
1	2	2	1.5475	1.5475	8	1.5532	1.5533	10
2	1	4	1.4676	1.4675	10	1.4735	1.4735	12
2	0	8	1.4452	1.4452	3	1.4530	1.4528	2
1	1	9	1.4322	1.4322	3			
1	2	5	1.4152	1.4152	2	1.4212	1.4211	1
0	3	0	1.3909	1.3909	5	1.3959	1.3957	5
0	0	12	1.33579	1.33575	3			

slightly in chemical composition, unit-cell parameters and physical properties.

The youngest mineral in this assemblage is represented by a second generation of diopside, which occurs as very small (always less than 1 mm) individuals of rather complex morphology. They correspond to “diopside II,” according to Keller (1977), while the much larger crystals of this mineral, grown before minrecordite, are equivalent to Keller’s “diopside I.” In our specimen, the minute diopside II individuals are emerald-green and completely transparent when perched on magnesian minrecordite. The much larger number of diopside II crystals, grown on pure minrecordite, are, as a rule, slightly opalescent, with a distinctive, lighter, bright bluish green color. Therefore the paragenetic sequence is as follows:

1. Calcite + zincian dolomite + duftite (also in small veins within the matrix).
2. Diopside I, in large euhedral emerald-green crystals.
3. Magnesian minrecordite, rarely associated with cerussite and calcite.
4. Minrecordite.
5. Diopside II, either bluish green or emerald-green in color, as emphasized above.

In many other diopside specimens from Tsumeb, a mineral was observed very similar in appearance to the above-mentioned minrecordite, both in the pearly luster of the crystals and in their evident saddle-shape. This mineral was shown, however, to be merely zincian dolomite or, in some cases, nearly pure dolomite; in the latter case the crystals are not markedly twisted. Because of the close external similarity of this zincian dolomite to minrecordite, some information about it will be given in a further section.

PHYSICAL and OPTICAL PROPERTIES

The minute minrecordite crystals exhibit, as their only form, the {10 $\bar{1}$ 4} rhombohedron, with markedly twisted and saddle-shaped faces. Minrecordite is distinguished also by its strong, sometimes dazzling, pearly luster and by the mosaic structure of the crystals. The {10 $\bar{1}$ 4} cleavage is prominent.

Mohs hardness is 3.5. Specific gravity, measured by immersion in Clerici's solution, is 3.45(2) for pure minrecordite and 3.32(2) for magnesian minrecordite. Calculated density values derived from unit cell parameters and chemical composition (see below) are 3.445 g/cm³ and 3.306 g/cm³ respectively.

Optically, minrecordite is uniaxial negative and strongly birefringent. The indices of refraction (Na light) are:

Minrecordite: $\omega = 1.750$ $\epsilon = 1.550$

Magnesian minrecordite: $\omega = 1.734$ $\epsilon = 1.542$

These values are approximate to ± 0.002 for minrecordite and ± 0.003 for magnesian minrecordite. Independent of the experimental precision, a larger dispersion of the results was noted for the magnesian variety. This may be related to slight compositional differences between individual crystals of this type.

No fluorescence was observed under longwave or shortwave ultraviolet light.

These results suggest that we are dealing with a trigonal carbonate containing a substantial amount of cations smaller than Ca, and with either an ordered, less symmetrical, dolomite-like or a disordered, calcite-like structural arrangement of the cations.

X-RAY CRYSTALLOGRAPHY

X-ray single-crystal study would have been desirable in order to determine the amount of distortion of coordination polyhedra around the cations. However, this study was impossible due to the inferior quality of the mosaic crystals.

A high-resolution powder diffraction pattern was recorded separately for minrecordite and for its magnesian variety. The step-scanning technique ($0.01^\circ 2\theta$ intervals) was adopted, operating with high resolution slits on two samples of about 3 mg each. The examined minerals were spread on the surface of a pure, powdered and compressed NaF support, allowing the NaF surface to remain exposed between sample grains. With this preparation technique, the NaF may also be used as a standard. The examined materials came from a number of different crystal clusters yielding the powder pattern of pure minrecordite, but from only two clusters having the pattern of the magnesian variety.

Observed and calculated $d_{(hkl)}$ values are given in Table 1. Both patterns are satisfactorily indexed in terms of a trigonal unit-cell, space group $R\bar{3}$. Some reflections are present, the indices of which violate the requirements of the $R\bar{3}c$ space group to which calcite belongs; this indicates that the mineral has an ordered, dolomite-like cation arrangement.

Least-squares calculation on the powder diffraction data resulted in the following unit-cell parameters:

Minrecordite

a	=	4.8183(4) Å
c	=	16.0295(10) Å
c/a	=	3.3268
V	=	322.28 Å ³
a_{rh}	=	6.0240 Å
α_{rh}	=	47° 09'

**Magnesian
Minrecordite**

a	=	4.8355(4) Å
c	=	16.1433(12) Å
c/a	=	3.3385
V	=	326.89 Å ³
a_{rh}	=	6.0622 Å
α_{rh}	=	47° 01'

These values are consistent with the chemical composition of the analyzed minrecordites (see below). They follow the linear variation rules given by Goldsmith and Graf (1958) for unit cell parameters of trigonal carbonates, as a function of their chemical composition.

CHEMISTRY

Minrecordite is very slowly soluble in cold dilute HCl. The solubility and accompanying effervescence increase with acid con-

centration and, more markedly, with temperature. The mineral is easily soluble in 2N HCl at 80° C.

The chemical determination of cations was performed by atomic absorption spectrometry (A.A.S.). Taking into account the physical and optical properties of the mineral, as well as the results of the X-ray diffractometer study, and because only very small quantities were available, no direct determination of CO₂ was attempted and all the values were calculated as carbonates.

For pure minrecordite, four separate microanalyses were performed, on four different crystal clusters. The results are given in Table 2. Though the single analyses differ slightly from each other, the atomic ratio between Ca and the sum of the other metals is always very close to unity. On the basis of 6 oxygens, the averaged values yield the formula:

$\text{Ca}_{0.975}(\text{Zn}_{0.917}\text{Mg}_{0.067}\text{Fe}_{0.034}\text{Mn}_{0.003})(\text{CO}_3)_2$

or, ideally, $\text{CaZn}(\text{CO}_3)$.

For magnesian minrecordite, two microanalyses were performed (Table 3), but only one of these on a well-purified sample. The results of these analyses yield the formula:

$\text{Ca}(\text{Zn}_{0.699}\text{Mg}_{0.134}\text{Ca}_{0.090}\text{Fe}_{0.068}\text{Mn}_{0.009})(\text{CO}_3)_2$.

Thus, magnesian minrecordite is a compositional variety less rich in Zn, and more calcian and magnesian in comparison with pure minrecordite. Its composition easily explains the lower indices of refraction and specific gravity values, and the larger unit-cell parameters, with respect to pure minrecordite.

The second analysis of magnesian minrecordite was performed on crystals not susceptible to hand-purification and greatly contaminated by admixed cerussite and calcite, both recognized (as the sole impurities) optically and by means of X-ray examination. Therefore the results, also given in Table 3, show a substantial amount of Pb, and excess Ca when compared with the content re-

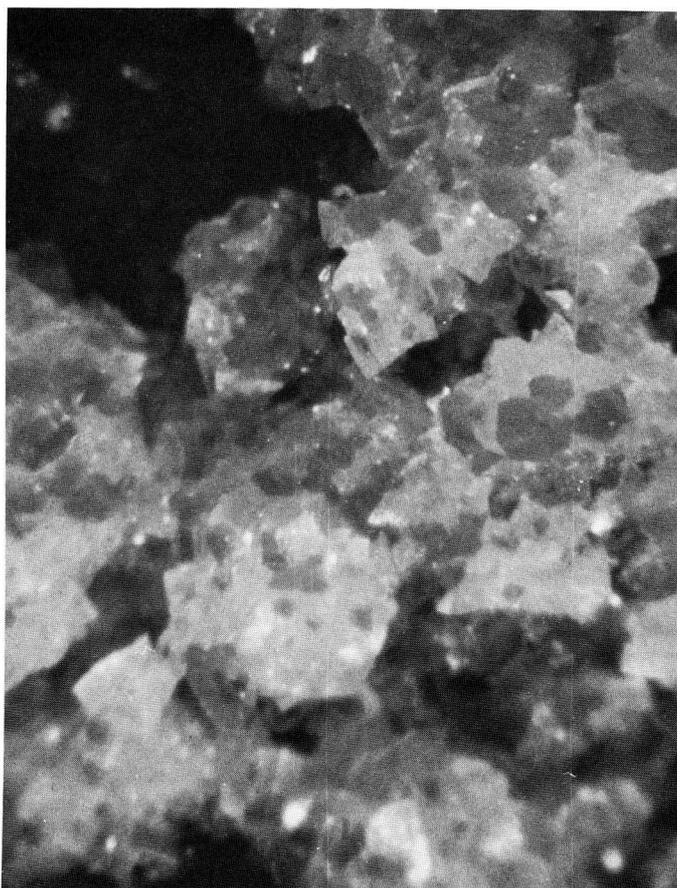


Figure 3. Very small, green diopside (II) crystals to 0.25 mm strewn across white minrecordite crystal clusters. Fioravanti specimen.

Table 2. Chemical analyses of minrecordite

		Sample I	Sample II	Sample III	Sample IV	Average
Weight Percent	CaCO ₃	44.69	44.34	45.01	41.85	43.97
	ZnCO ₃	51.22	50.30	50.86	53.85	51.56
	MgCO ₃	1.99	4.33	2.08	1.66	2.52
	FeCO ₃	1.69	1.14	2.19	2.12	1.78
	MnCO ₃	0.15	0.14	0.18	0.18	0.16
	Sum	99.74	100.25	100.32	99.66	99.99
Molar Ratios Basis: 6 oxygens	CaCO ₃	0.9984	0.9973	0.9988	0.9426	0.9793
	ZnCO ₃	0.9133	0.8850	0.9009	0.9682	0.9167
	MgCO ₃	0.0528	0.1133	0.0548	0.0444	0.0666
	FeCO ₃	0.0326	0.0217	0.0420	0.0413	0.0343
	MnCO ₃	0.0029	0.0027	0.0035	0.0035	0.0031

quired by a dolomite-like formula.

In spite of this, it seems possible to obtain some chemical information by calculating a formula after the subtraction of all the PbCO₃ and assuming the atomic ratio between Ca and the sum of the remaining cations is equal to 1. The formula calculated on this basis is:



Obviously, no definite information is available about the ratio between Ca and the sum of the other metals. It is evident, however, than Zn is dominant among the small cations, though accompanied by higher amounts of other cations (especially Mg) when compared with the formula obtained for magnesian minrecordite in pure crystals.

Among the minor elements, Sr, Pb, Cu, and Co were sought in all the analyzed materials. In pure minrecordite, they were not found (each less than 10 ppm) with the exception of Cu in analysis IV (1300 ppm), probably due to a diopside impurity. In magnesian minrecordite, Sr (85 ppm) and traces of Co (about 20–25 ppm) were detected. Larger amounts of Sr (160 ppm) are present in the contaminated sample, probably linked with the cerussite or calcite impurities.

ASSOCIATED ZINCIAN DOLOMITES

As pointed out above, a zincian variety of dolomite has been identified in the small veins of carbonates, occurring within the matrix, or interposed between the matrix and diopside I crystals. In these occurrences, zincian dolomite is always admixed with calcite and duftite, as revealed by optical and X-ray evidence. No other minerals are present, excepting some malachite needles.

Chemical analyses of these materials were performed by means of A.A.S. They gave the results quoted in Table 4, sample I (small veins within the matrix) and II (between matrix and diopside I). Owing to the ascertained presence of admixed calcite, the composition of these zincian dolomites cannot be definitely established. On the assumption of an atomic ratio 1:1 between Ca and the sum of smaller cations, the following formulas are calculated on the basis of 6 oxygens:



for samples I and II respectively.

As mentioned above, and as shown in Table 4, zincian dolomite and calcite are admixed in these occurrences with duftite and malachite. Duftite percentages were calculated on the basis of determined Pb contents: the minor amounts of Cu still remaining were calculated as malachite. No direct determination of As was carried out, but the presence of this element was qualitatively ascertained.

A third analysis of zincian dolomite was obtained from pearly white, twisted, rhombohedral crystals occurring on another diop-

Table 3. Chemical analyses of magnesian minrecordite

		Sample I	Sample II	
			II-a	II-b
Weight Percent	PbCO ₃	///	41.95	///
	CaCO ₃	50.65	41.25	46.81
	ZnCO ₃	40.67	11.50	35.84
	MgCO ₃	5.24	3.18	9.91
	FeCO ₃	3.67	2.20	6.85
	MnCO ₃	0.46	0.19	0.59
Sum	100.69	100.27	100.00	
Molar Ratios Basis: 6 oxygens	CaCO ₃	1.0904	///	1.0000
	ZnCO ₃	0.6988	///	0.6112
	MgCO ₃	0.1339	///	0.2513
	FeCO ₃	0.0683	///	0.1265
	MnCO ₃	0.0086	///	0.0110

Note – II-a column: weight percent obtained for a cerussite and calcite admixed minrecordite.

II-b column: recalculated weight percent after subtraction of all the PbCO₃ and 26.23 percent CaCO₃ (excess of CaCO₃ with respect to a carbonate with 1:1 ratio between Ca and the sum of other cations).

tase specimen from Tsumeb, and quite similar to minrecordite in appearance.

Unlike samples I and II, this material was very pure, and thus a fully reliable formula may be calculated directly from the analytical results. On the basis of 6 oxygens, we have:



which corresponds to a far less zincian dolomite.

Traces of Co were detected in all these three zincian dolomites. Sr is also present; it has a higher concentration (185 ppm) in the less zincian dolomite.

DISCUSSION

The natural occurrence of a new mineral phase which is structurally a member of the dolomite series, and is a presumably very

Table 4. Chemical analyses of zincian dolomite

		Sample I		Sample II		Sample III
		I-a	I-b	II-a	II-b	
Weight Percent	CaCO ₃	53.52	51.58	52.21	51.23	53.33
	ZnCO ₃	11.88	15.11	12.73	15.62	3.72
	MgCO ₃	26.11	33.21	25.54	31.33	40.12
	FeCO ₃	0.03	0.04	1.34	1.64	2.80
	MnCO ₃	0.05	0.06	0.15	0.18	0.23
	Duftite	7.58	/	7.64	/	/
	Malachite	0.33	/	0.21	/	/
	Sum	99.50	100.00	99.82	100.00	100.00
Molar Ratios Basis: 6 oxygens	CaCO ₃	1.0000		1.0000		1.0012
	ZnCO ₃	0.2339		0.2434		0.0557
	MgCO ₃	0.7643		0.7259		0.8939
	FeCO ₃	0.0007		0.0276		0.0454
	MnCO ₃	0.0011		0.0031		0.0038

Note – Columns I-b and II-b: recalculated weight percent after subtraction of duftite and malachite, and of 12.98 and 10.44 percent CaCO₃ respectively (no excess CaCO₃ in Sample III). See text.

rare Tsumeb secondary mineral, seems to be conclusively established. This conclusion is fully supported by the very good agreement between chemical, optical and physical data. As far as chemical composition, indices of refraction and specific gravity are concerned, and using the well-known Gladstone-Dale relationship, compatibility indices of -0.018 , -0.015 and -0.011 can be found for minrecordite (averaged values) and magnesian minrecordite (analyses I and II) respectively. Such values are listed as "superior" by Mandarino (1979). It is significant that the best agreement is observed for sample II of magnesian minrecordite: it gives full justification for the assumptions made in order to calculate its formula.

The possible existence of a pure compound $\text{CaZn}(\text{CO}_3)_2$ with a dolomite-like, ordered structure (and more generally the stability of transition metal "dolomites") was recently discussed by Rosenberg and Foit (1979). According to these authors, small cation size cannot be the only critical factor controlling the stability of these structures, which chiefly depends upon the distortion of R^{+2}O_6 octahedra, R^{+2} being a cation of a transition metal. Octahedral distortion apparently raises the free energy of formation of these dolomite-like structures, until they become metastable phases, when the sum of free energies for two binary disordered solid solutions is reached.

Many works on this subject (e.g. Goldsmith and Northrop, 1965) suggest the following series in order of decreasing stability:

$\text{Mg} \gg \text{Mn} > \text{Zn} > \text{Fe} > \text{Co} > \text{Ni} \gg \text{Cu}$

According to Rosenberg and Foit (1979), the stability limit for a dolomite-like structure occurs in the vicinity of Zn in the above series. These authors state that: "Zn-dolomite is probably not a stable phase, although very extensive solid solution toward $\text{CaZn}(\text{CO}_3)_2$ is predicted." Actually, accepting the hypotheses assumed by Rosenberg and Foit, it is possible to calculate, for $\text{Ca}(\text{Zn},\text{Mg})(\text{CO}_3)_2$ a stability limit, which lies at a maximum Zn content (in atoms) between 85 and 90 percent of the small cations. We find, for pure minrecordite from Tsumeb, a value of 91.7 percent (or a little more, including Fe), which seems to agree with the provisions, taking into account the approximations involved in Rosenberg and Foit's calculation.

Moreover, it is likely that minrecordite is not grown under ideal conditions of chemical equilibrium. Analytical data seem to indicate that minrecordite chemical composition varies from one point of growth to the next. It is possible that surface equilibria between solutions and growing crystals may have played an important role in the formation of this mineral (and of the associated zincian dolomite). This was pointed out by Tsusue (1967) for rhodochrosite and magnesian kutnohorite, and by other authors (e.g. Sims and Barton, 1961) for different hydrothermal minerals.

The paragenetic position of minrecordite falls within the sequence outlined by Keller (1977): dolomite \rightarrow duftite \rightarrow plancheite \rightarrow diopside I \rightarrow calcite \rightarrow diopside II. Apart from the absence of plancheite, the main difference between the above-mentioned sequence and that observed on the minrecordite-bearing specimen is the presence of minrecordite instead of calcite in the position stated by Keller. However, the inspection of many diopside druses from Tsumeb leads us to consider the occurrence of a dolomitic phase (as the intermediate between diopside I and II) as not uncommon. These dolomitic phases are most commonly represented by nearly pure dolomite or, less commonly, by zincian dolomite. The deposition of minrecordite is probably due not only to an adequate concentration of Zn in the circulating solutions, but also to a quite uncommon scarcity of Mg in the latter, and perhaps (Keller, 1977) to a slightly higher environmental pH. The deposition of crystals of composition not too different from the ideal $\text{CaZn}(\text{CO}_3)_2$ must, in any case, be considered a rather uncommon event.

A careful examination of the many diopside druses from Tsumeb might result in the discovery of other minrecordite specimens. Their

identification must be achieved by accurate chemical, optical or X-ray studies because of the close similarity, in outward appearance, to some dolomite (or, particularly, zincian dolomite) crystals.

With regard to the presence of zincian dolomite among the secondary minerals from Tsumeb, this compositional variety was previously described (or merely mentioned) for the locality by Hurlbut (1957); Strunz, Söhngge and Geier (1958); Geier and Weber (1958); Geier (1974); and Pinch and Wilson (1977). In these studies, the name "Zn-dolomite" (or "zinkdolomit") was used to mean a compositional variety, as stated, for example, by Geier (1974). On the other hand, Rosenberg and Foit (1979) used "Zn-dolomite" as a name for the compound $\text{CaZn}(\text{CO}_3)_2$. Taking into account this ambiguity, and because of the introduction of the name minrecordite, it seems better to drop "zinkdolomit" and "Zn-dolomite," in favor of *zincian dolomite*, when the purpose is to designate a compositional variety.

All the zincian dolomites previously described for Tsumeb lie below this compositional limit: their maximum Zn value is quoted as 21.65 percent ZnCO_3 (private communication of Geier in Strunz, 1970). Assuming that no other substituents for Mg, in significant amounts, are contained in it, this would correspond to an atomic ratio Zn:Mg not far from 1:2.

A zincian dolomite described by Jasienska and Zabinski (1972) seems to be much richer in Zn. This was found as a major mineral component of an oxidized zinc ore from the Waryński mine, near Bytom (Upper Silesia, Poland). These authors state that, in this solid solution, the Zn:Mg atomic ratio "is approximately equal to or even exceeds 1." The results of microprobe analyses were: Ca = 16-18 percent, Zn = 10-14 percent, Mg = 3-4 percent, Fe < 1 percent. If the semiquantitative evidence from these values is confirmed, then also these mixed crystals from Silesia might be classed within the minrecordite range.

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ADDENDUM

During 1980 and the first half of 1981, we examined vast numbers of diopside druses from Tsumeb in the hope of encountering another minrecordite specimen.

After the above manuscript was written, we were fortunate enough to find, among a great many dolomite and some zincian dolomite-bearing diopside druses, a small (18 x 26 mm) specimen with a number of minrecordite crystals.

These crystals have the very same external appearance as described here for pure minrecordite crystals. A quantitative estimation of the major elements indicated, however, an atomic ratio Ca : Zn : Mg = 1.00 : 0.65 : 0.25. Fe and Mn were not determined; the analysis sums to 97.6, calculating the metals as carbonates. In spite of its outward appearance, this mineral is therefore a magnesian minrecordite.

In this new magnesian minrecordite specimen, some clear rhombs are present, quite similar to the first-found magnesian minrecordite, and apparently formed after diopside but before minrecordite. These rhombs proved to be merely zincian dolomite with an atomic ratio Ca : Zn : Mg = 1.00 : 0.19 : 0.78 (Fe and Mn were not sought).

This specimen was kindly submitted to our attention by Natale Borghi, a skilled and esteemed mineral collector and dealer in Rome. It was obtained about six years ago from Sid Pieters of Windhoek, Namibia.

The new chemical data, though approximate, strengthen the conclusion that compositional differences may exist among minrec-

ordite crystals grown at different locations within the Tsumeb oxidation zone, or even at the same point but at different times. Therefore, the chemistry of growing minrecordite appears very sensitive to the composition of the circulating solutions.

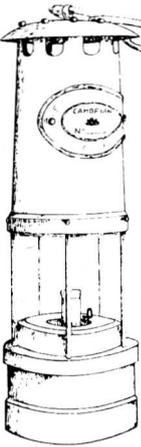
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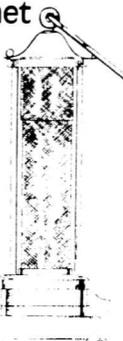
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