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Mn- and F-bearing rasvumite in natrocarbonatite at Oldoinyo Lengai volcano, Tanzania

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ABSTRACT

Several K-Fe sulphide minerals have been described from natrocarbonatite lavas erupted from the Tanzanian volcano Oldoinyo Lengai but uncertainty remains about their exact identity. They do not appear to be any of the established K-Fe sulphides according to Dawson *et al.* (1995) and Mitchell (1997). Here, we describe yet another variant which is a Mn- and F-bearing variety of rasvumite. It appears to have formed by reaction of Fe alabandite grains with natrocarbonatite magma and occurs as minute rims on the alabandite. Its formula is: $(K_{0.94}Na_{0.06})(Fe_{1.91}Mn_{0.13}Ca_{0.01}Sr_{0.01})(S_{2.06}F_{0.24}Cl_{0.04})$.

KEYWORDS: K-Fe sulphide, natrocarbonatite, Oldoinyo Lengai, rasvumite, Tanzania, manganese, fluorine.

Introduction

K-FE SULPHIDES occur as accessory minerals in many of the natrocarbonatite lavas of Oldoinyo Lengai volcano in Tanzania but their identity remains unclear. Dawson *et al.* (1995, Table 2, anal. 4) give the composition of a K-Fe sulphide from a 1988 flow and conclude that it has the formula $K(Fe,MnZn,Pb)_3S_4$ and "is unlike other reported K-sulphides". Mitchell (1997) presents 11 analyses of K-Fe sulphides from the flow of October 17th 1995, in which there is a much higher Na content than reported by Dawson *et al.* (1995), and 2 from the 'blocky flow' described by Dawson *et al.* (1995). He concludes that the minerals are none of the established K-Fe sulphide minerals (rasvumite, djerfisherite, bartonite, thalfenisite, thalcusite, murunite) but that they represent complex solid solutions involving KFe_3S_4, $K_2Fe_3S_4$, and KFe_2S_3. Both Mitchell (1997) and Dawson *et al.* (1995, 1996) stress that these K-Fe sulphides are not rasvumite (KFe_2S_3).

Against this background we now report a Mn- and F-bearing K-Fe sulphide mineral which occurs as probable reaction rims around grains of alabandite. Alabandite is ideally a Mn sulphide (MnS) but the mineral in the natrocarbonatite lavas is Fe-alabandite (Table 1), as noted by Peterson (1990), Keller and Krafft (1990), Jago (1991), and Dawson *et al.* (1995). It was first reported by Gittins and McKie (1980) and has been observed in accessory quantities by everyone who has subsequently examined the lavas. The K-Fe sulphide mineral described now was found in the 1988 flows and occurs as strongly fractured mantles (<10 μm thick) surrounding single grains and multi-grain aggregates of alabandite. The mantles are not intergrown with the quenched matrix of the lava and have an irregular inner contact with alabandite. Islands of alabandite grains persist in some areas of the K-Fe sulphide mineral that surrounds larger grains of alabandite. We interpret the mantles as representing reaction between alabandite and natrocarbonatite magma.

Two analyses of the mineral which forms the rims are presented in Table 1 together with one of known rasvumite for comparison and two of Oldoinyo Lengai alabandite. The mineral is unusual in containing even more Mn than those

TABLE 1. Analyses of Mn- and F-bearing K Fe sulphide, rasvumite and alabandite

	1	2	3	4	5
K	14.91	15.20	16.3	nil	nil
Na	0.62	0.39	n.a.	nil	nil
Fe	43.26	43.90	45.2	17.95	17.23
Mn	2.91	2.97	n.a	46.63	46.23
Mg	n.a.	n.a.	n.a	0.02	0.05
Ti	n.a.	n.a.	n.a	0.07	0.08
Ni	n.a.	n.a.	n.a	nil	nil
Ca	0.15	n.a.	n.a.	nil	nil
Sr	0.27	0.14	n.a	nil	nil
S	35.26	34.47	38.0	34.80	34.67
F	1.88	1.92	n.a.	nil	nil
Cl	0.68	0.67	n.a	nil	nil
Sum	99.94	99.91	99.5	99.39	98.26
Formula based on a total of 6 atoms					
K	0.93	0.95			
Na	0.07	0.04			
Fe	1.89	1.93			
Mn	0.13	0.13			
Mg	–	–			
Ti	–	–			
Ni	–	–			
Ca	–	0.01			
Sr	–	0.01			
S	2.68	2.64			
F	0.24	0.25			
Cl	0.04	0.05			

1, 2. Mn- and F-bearing K Fe sulphide thought to be a type of rasvumite; occurs as reaction rims on alabandite grains within natrocarbonatite lava. November 1988 flow, Oldoinyo Lengai.

3. Rasvumite from Khibina intrusion, Kola Peninsula, Russia. Czamanske *et al.* (1979).

4, 5. Alabandite in natrocarbonatite flow of November 1988 flow, Oldoinyo Lengai. Jago (1991).

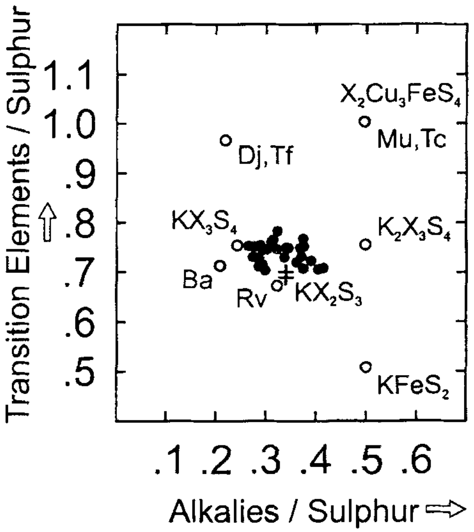

FIG. 1. Composition of KFe sulphide minerals from Oldoinyo Lengai natrocarbonatites in terms of transition metals/sulphur *vs* alkalies/sulphur (atomic) (+). Also shown (as solid circles) are the compositions of KFe sulphide minerals from Mitchell (1997) along with the compositions of djerfisherite (Dj), thalfensite (Tf), murunite (Mu), thalcusite (Tc), bartonite (Ba) and rasvumite (Rv).

analysed by Mitchell, but has less Na substituting the K and has a significant content of F and Cl. It has the formula $(K_{0.94}Na_{0.06})(Fe_{1.91}Mn_{0.13}Ca_{0.01}Sr_{0.01})(S_{2.66}F_{0.24}Cl_{0.04})$ and appears to be a type of rasvumite in which part of the Fe site is replaced by Mn, and about 10% of the S site is replaced by F and Cl. In Fig. 1 we show both analyses along with the data from Mitchell (1997, Fig. 5). Dawson *et al.* (1996) mention a K-Fe sulphide in a 1993 flow with 0.67 wt.% Cl, the same as we report here, but assume that it represents overlap with surrounding sylvite; perhaps, however, the Cl value is correct. No F value is given.

Our data further reinforce the concept of there being a range of manganiferous K-Fe sulphides in the natrocarbonatites of Oldoinyo Lengai. It is not surprising that our Mn- and F-bearing rasvumite is both more manganiferous than any so far described and also contains F and Cl. Its occurrence as probable reaction rims between alabandite and natrocarbonatite magma means that there were readily available sources of all the necessary elements: Mn, Fe and S in the alabandite, and K, Na, F, and Cl in the magma. The question has been raised as to whether alabandite crystallized from the natrocarbonatite magma or is a xenocrystic mineral (Mitchell, 1997) or, alternatively, crystallized from an immiscible liquid (Peterson, 1990). The matter has more than semantic interest since it bears on the ultimate course of crystallization of natrocarbonatite magma and the degree of evolution that this magma has incurred (Gittins and Jago, 1998). Whether alabandite originally crystallized from natrocarbonatite magma or was later incorporated into it as a xenocryst is less important than the fact that it was originally in equilibrium with the magma and later ceased to be. It appears to have reacted with the magma. Although not reported by other observers of alabandite in natrocarbonatite, it might well have been missed since the rims are tiny and alabandite is not one of the minerals of these unusual lavas that has attracted very detailed study.

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References

Czamanske, G.K., Erd, R.C., Sokolova, M.N., Dobrovol'skaya, M.G. and Dmitrieva, M.T. (1979) New data on rasvumite and djerfisherite. *Amer. Mineral.* **64**, 776–8.

Dawson, J.B., Pinkerton, H., Norton, G.E., Pyle, D.M., Browning, P., Jackson, D. and Fallick, A.E. (1995) Petrology and geochemistry of Oldoinyo Lengai lavas extruded in November 1988: magma source, ascent and crystallization. In *Carbonatite Volcanism. Oldoinyo Lengai and the Petrogenesis of natrocarbonatite* (K. Bell and J. Keller, eds.) IAVCEI Proceedings in Volcanology, **4**, 47–69.

Dawson, J.B., Pyle, D.M. and Pinkerton, H. (1996) Evolution of natro-carbonatite from a wollastonite nephelinite parent: evidence from the June, 1993 eruption of Oldoinyo Lengai. *J. Geol.*, **104**, 41–54.

Gittins, J. and Jago, B.C. (1998) Differentiation of natrocarbonatite magma at Oldoinyo Lengai volcano, Tanzania. *Mineral. Mag.* **62**, 759–68.

Gittins, J. and McKie, D. (1980) Alkalic carbonatite magmas: Oldoinyo Lengai and its wider implications. *Lithos,* **13**, 213–5.

Jago, B.C. (1991) *The role of fluorine in the evolution of alkali-bearing carbonatites and the crystallization of carbonatite hosted apatite and pyrochlore deposits.* Ph.D. dissertation, University of Toronto, Canada.

Keller, J. and Krafft, M. (1990) Effusive natrocarbonatite activity of Oldoinyo Lengai, June 1988. *Bull. Volcanol.*, **52**, 629–45.

Mitchell, R.H. (1997) Carbonate-carbonate immiscibility, neighborite and potassium iron sulphide from Oldoinyo Lengai natrocarbonatite. *Mineral. Mag.*, **61**, 779–89.

Peterson, T.D. (1990) Petrology of natrocarbonatite. *Contrib. Mineral. Petrol.*, **105**, 143–55.

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