

COPIAPITE FROM THE SANTA MARIA MTS.,
EASTERN RIVERSIDE CO., CALIFORNIA

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Several specimens of a ferric sulphate were received by the Brush Mineral Collection several years ago from Mr. L. J. Childs of Rialto, California. These specimens were preserved under a bell jar to prevent alteration. Recently the writers have examined this material and selected pure material for analysis.

The mineral, which proved to be copiapite, is from the Santa Maria Mts., Eastern Riverside Co., California. It is yellowish brown in color and has a crystalline structure. With the copiapite occurs amarantite and an altered white mineral which could not be identified. The copiapite proved upon microscopic examination to be homogeneous and free from other minerals.

Professor W. E. Ford examined the mineral optically and reports that it is biaxial, optically positive, alpha undetermined, beta equal to 1.53, and gamma equal to 1.57; pleochroism Z equals yellow and Y nearly colorless. Possesses one perfect cleavage normal to obtuse bisectrix.

The analysis was made of the purest material carefully selected and preserved from any dehydration in a tightly stoppered specimen tube. Insoluble material, ferric oxide, calcium oxide, and magnesium oxide were determined by the standard methods. Aluminium oxide, ferrous oxide and alkalis were absent. It was realized that the determination of water was most important and that a very careful and accurate determination was necessary. Water was determined by heating a weighed sample over which a current of *dry* air was led and passing the water vapor given off thru a layer of heated anhydrous sodium carbonate to remove any sulphuric anhydride and collecting the water in weighed calcium chloride and phosphorus pentoxide tubes.

The analyses and ratios are here quoted:—

	I	II	Mean	Molecular ratios	Revised ratios
Fe ₂ O ₃	26.46%	26.32%	26.39%	0.166	0.166 equal 2.00
SO ₃	39.64	39.93	39.79	0.497	0.413 equal 4.97
H ₂ O	29.99	29.85	29.92	1.661	1.582 equal 19.03
CaO	0.30	0.24	0.27	0.005	
MgO	3.20	3.18	3.19	0.079	
Insoluble	0.30	0.29	0.30		
Total	99.89%	99.81%	99.86%		

The magnesium oxide and calcium oxide are considered as impurities and the magnesium oxide subtracted as kieserite ($\text{MgSO}_4 \cdot \text{H}_2\text{O}$), and the calcium oxide as anhydrite CaSO_4 , to obtain the revised ratios. The molecular ratios are then $2 \text{Fe}_2\text{O}_3 \cdot 5 \text{SO}_3 \cdot 19 \text{H}_2\text{O}$ which we propose to write $\text{Fe}_4(\text{OH})_2 (\text{SO}_4)_5 \cdot 18 \text{H}_2\text{O}$.

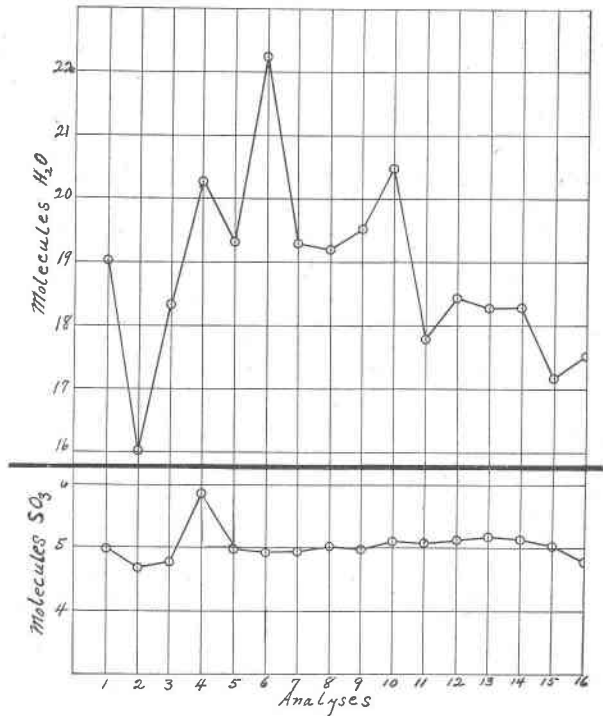
To show whether the number of molecules of sulphur trioxide and water combined with $2 \text{Fe}_2\text{O}_3$ was constant we recalculated the ratios of previous analyses which appear to be most reliable, subtracting the sulphates of the bivalent metals as the monohydrate. The amount of calcium sulphate is so small when present that it makes no difference whether it is considered as anhydrite or as gypsum. The reason for considering these sulphates as monohydrates is because this is the form which crystallizes from solutions containing considerable quantities of other dissolved substances.¹ The following data and graphical presentation (Lower Figure) show that the ratio $2 \text{Fe}_2\text{O}_3 : \text{SO}_3$ is constant except for one analysis which had 5% insoluble, and was mixed with a white mineral. The ratio $2 \text{Fe}_2\text{O}_3 : \text{H}_2\text{O}$ is not as constant as might be expected (Upper Figure), but the difficulty in obtaining a good water determination (determination of H_2O by difference in many cases), difficulty in securing fresh material, and the low molecular weight of water explain these divergences.

Scharizer² recognizes two types of copiapite—one free from bivalent metals, and the other containing them. We cannot accept this distinction and prefer to regard bivalent bases as impurities present as the hydrated sulphates until it can be definitely established by experiment that ferric sulphate can form addition products with bivalent sulphates. This could be shown quite definitely by means of a solubility diagram but at present this data is lacking.

There is considerable work still to be done on the hydrated sulphate minerals. When suitable material becomes available we hope to continue our work. Others who have at their disposal unaltered material should help to establish the chemical composition and relationships of these minerals. In conclusion we wish to acknowledge our indebtedness to Professor H. W. Foote for his inspiration, suggestions and criticism.

¹ Foote and Scholes: *J. Am. Chem. Soc.*, **33**, 1309 (1911).

² Scharizer: *Zeit. f. Kryst.*, **52**, 372 (1913).



ANALYSES GRAPHED

1. Schairer and Lawson: Santa Maria Mts. Eastern Riverside Co. Cal. This paper.
2. Darapsky: Tierra amarilla, *Jahrb. Min.*, **1**, 62, (1890).
3. Melville and Lindgren: Sulphur Banks Cal., *U. S. Geol. Surv., Bull.* **61**, (1890).
4. Schaller: Leona Heights, Alameda Co. Cal., *Bull. Dept. Geol. Univ. Cal.*, **3**, 214, (1903). Few prisms of a colorless white mineral intermixed.
5. Melville and Lindgren: Knoxville Cal., *U. S. Geol. Survey, Bull.* **61**, (1890).
6. Mauzelius: Falun, *Geol. Fören. Förh.*, **17**, 306, (1895).
- 7&8. Scharizer: South America, *Zeit. Kryst.*, **52**, 372, (1913).
- 9&10. Scharizer: Rammelsberg, *Zeit. Kryst.*, **52**, 372, (1913).
11. Makintosh: Tierra amarilla, *Am. J. Sci.*, **38**, 245, (1889).
12. Ahrend and Ulrich: *Rammelsberg Zeitschr. f.d. ges. Naturw. Halle*, **3**, 32, (1854).
13. Linck: Chili, *Zeit. Kryst.*, **15**, 17, (1888).
14. Scharizer: Sierra de L'Alcapa rossa, *Zeit. Kryst.*, **52**, 372, (1913).
15. Posnjak and Merwin: Artificial, *J. Am. Chem. Soc.*, **44**, 1965, (1922). This preparation may have been somewhat dehydrated by washing with alcohol and ether.
16. Scharizer: Artificial, *Zeit. Kryst.*, **52**, 372, (1913).