

refraction of sericite from the Carroll-Driscoll Mine in Boise County, Idaho, as  $1.585 \pm .003$  for beta and  $1.587 \pm .003$  for gamma. Both of these indices are close to the single mean index 1.580 found for the material analyzed. The indices for sericite and muscovite are similar, but paragonite has indices somewhat higher, 1.60.<sup>14</sup> Because of its high soda content a further check upon its identification seemed desirable, hence, a sample was sent to Dr. Paul F. Kerr of Columbia University, for *x*-ray analysis. He reported that the *x*-ray pattern was that of the mineral sericite, thus furnishing conclusive proof as to the identification of the mineral.

#### ORIGIN

As noted above the sericite occurs scattered irregularly through the conglomerate at the top of Pilot Knob. This conglomerate contains many varieties of rocks but certain ones have evidently been more susceptible to the type of alteration that produced the sericite. Although commonly derived from orthoclase or microcline, sericite may also be derived from plagioclase feldspars. The composition of the sericite from Pilot Knob suggests that it was derived from plagioclase or that the potash had been replaced by sodium. A mixture of albite and orthoclase might well have been the original source material thus furnishing both the alkalis.

From the above data on its physical, chemical, the optical properties that could be determined, and the *x*-ray pattern, the mineral undoubtedly belongs to the muscovite mica group of minerals and is sericite.

#### LINEAR MINERALOGICAL ARITHMETIC

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In calculating the norm of a rock from a chemical analysis it is customary to divide the percentages of the oxides by the molecular weights to obtain the molecular proportions, or to consult tables of molecular proportions. From these proportions the minerals are calculated by multiplying certain molecular proportions by the molecular weight of the mineral concerned. With tables giving the molecular proportions to three decimal places the total mineral percentage seldom agrees with the total for the analysis.

<sup>14</sup> Larsen, Esper S., *The Microscopic Determination of Nonopaque Minerals, U. S. Geol. Survey, Bull. 679, p. 254.*

In the present paper a graphic method of determining molecular proportions with a high degree of accuracy and the calculation of the mineral percentages is shown. In figure 1 the vertical co-ordinates give percentages and the horizontal ones from the right give molecular proportions or the percentage of the compound concerned divided by its molecular weight.

For demonstration a theoretical analysis obtained by adding the percentages of the oxides in calcite, magnetite, andradite, anorthite and grossularite and dividing by five was taken. For comparison the molecular parts tabulated in Kemp's *Handbook of Rocks* were used for arithmetical calculation along with a direct calculation by the writer. The molecular parts to be taken directly or deduced from the tables of Holmes and Von Eckerman are also added but not used for calculation. (Table I.)

TABLE I  
THEORETICAL ANALYSIS

Per cent	Molecular Parts					
	Kemp	Holmes	Parsons	Parsons Graphic	Von Eck.	
SiO <sub>2</sub>	23.74	.396	.396	.3957	.3960	.3937
Al <sub>2</sub> O <sub>3</sub>	11.88	.116	.117	.1165	.1162	.1162
Fe <sub>2</sub> O <sub>3</sub>	20.10	.125	.126±	.1256	.1258	.1259
FeO	6.2	.086	.086	.0861	.0866	.0863
CaO	29.28	.523	.524	.5229	.5231	.5220
CO <sub>2</sub>	8.8	.200	.200	.2000	.2000	.2000

The percentages found using Kemp, Parsons and Parsons Graphic are as follows:

	Kemp	Parsons	Parsons Graphic
Calcite	20.000	20.0000	19.99
Magnetite	19.952	19.9752	20.00
Andradite	19.812	20.0666	19.99
Grossularite	20.250	19.7775	20.00
Anorthite	19.738	20.1689	19.99
Quartz	0.012	0.0150	—
	99.764	100.0032	99.97

In proceeding by the graphical method the original chart was made one metre square and on the left hand the molecular weights were laid off as vertical co-ordinates. These points were connected

with the origin at the lower right hand corner. Figure 1 is a portion of the original chart. Points were then determined indicating the percentages of the different constituents shown in the analysis and automatically the molecular proportions were marked off. Calcite was first determined by drawing a vertical line from the  $\text{CO}_2$  point to the  $\text{CaCO}_3$ . In similar manner magnetite was determined from the  $\text{FeO}$ , leaving an excess of  $\text{Fe}_2\text{O}_3$  which was transferred to the origin thus marking off the point for drawing the line for andradite.

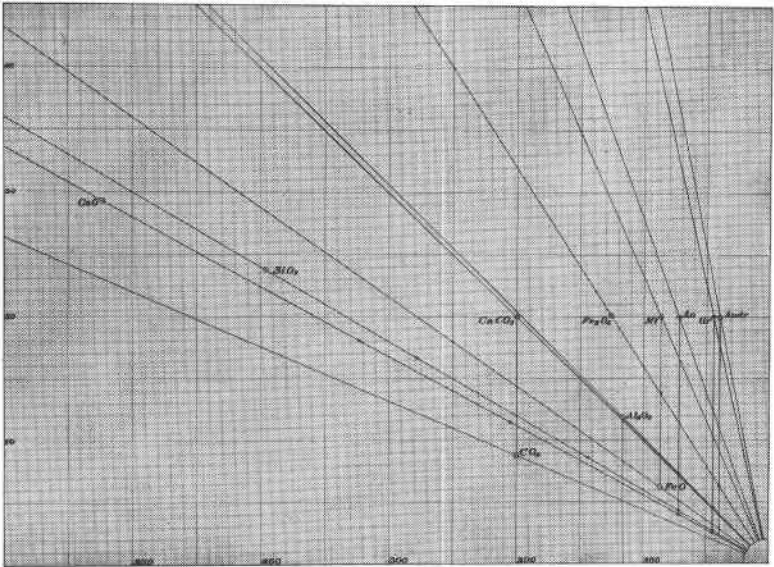


FIG. 1

The residue was now lime, alumina and silica. The quantity of lime that was used up in calcite and andradite was now subtracted from the total lime and a vertical line drawn from the point representing the  $\text{Al}_2\text{O}_3$ . Molecularly the lime was in excess of the alumina. This excess was divided by two and subtracted from the alumina value, thus locating the point through which the vertical line should be drawn for the anorthite. This same value was measured from the origin to indicate the point through which the vertical line should be drawn for the grossularite. When this was done the quantities of silica used for grossularite and andradite were subtracted from the total by means of dividers and the residue was so nearly bi-



component mixture. Possibly more has been written concerning this in connection with the determination of the percentage of iron in an ore when the specific gravity is known.

In general determinations of percentages of any element from the specific gravity can probably not claim a greater accuracy than  $\pm 1$  per cent, but the difference between the arithmetical method and the graphic method will not be greater than 0.2 per cent. The method of determining the percentage of iron in a two component system consisting of quartz and magnetite is shown in figure 2.

In figure 2 the specific gravity of quartz is laid off as a vertical co-ordinate on the left and the specific gravity of magnetite on the right. The line  $ap$  gives the specific gravity of any and every mixture of these two by bulk. The line  $aq$  is the dividing line between quartz and magnetite. The line  $bh$  is the 100% line. Magnetite contains 72+ per cent of iron.

$$\frac{cd}{ac} = \frac{fg}{eg} = \frac{72}{100}$$

Now for any mixture of quartz and magnetite (in the figure equal parts are taken) join the origin  $q$  with the point marked by the specific gravity  $l$  and produce to the 100 per cent line at  $h$ . Draw the line  $hk$ . Then

$$\frac{no}{lo} = \frac{jk}{hk} = 47.46\%$$

Arithmetical calculation gave 47.57%.

This graphic method provides an easy check on concentration and may be modified so as to introduce the average specific gravity of a rock instead of using that of quartz. In general it will not be applicable to mixtures of liquids for usually a change in volume is involved.

#### SPECTROGRAPHIC EXAMINATION OF SMOKY AND ORDINARY QUARTZ FROM RINCON, CALIF.

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Inasmuch as the color of smoky quartz is attributed by many investigators<sup>1,2,3,6</sup> to the presence of finely divided particles of

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<sup>1</sup> Holden, *Am. Mineral.*, vol. 10, pp. 203-52, 1925.