TECHNIQUE FOR OPTICAL IDENTIFICATION OF IRON-BEARING DOLOMITES[1]

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Introduction

This brief paper describing J. E. Howell's optical technique for identification of iron-bearing dolomites is being published posthumously. Dr. Howell was drowned while making studies in the Labrador Iron Belt in the summer of 1954. The technique was extracted from Dr. Howell's unpublished Ph.D. Thesis (1954), which was based on field studies made for the Geological Survey of Canada. It was developed to test for compositional differences between the dolomite from fragments and from the matrix of dolomitic arenites, because *x*-ray powder patterns failed to solve the problem. The method, which is an application of the basic principles outlined by Emmons (1943), is based on a direct relation between the refractive indices of carbonates and their chemical composition, and is simply a rapid and accurate method for determining a critical refractive index.

Historical Background

The dolomite structure as described in Dana's System of Mineralogy (1951) page 141, is a distorted "NaCl" structure in which the "Cl" anion. is replaced by the "CO_3" anion. "It is essentially an ordered sorting appearing in the calcite-magnesite random-substitution series, when Ca : Mg$\sim$1 : 1." Calcium can substitute for magnesium in magnesium sites and similarly magnesium can substitute in calcium sites only to a very limited extent. The similarity between the ionic radii of magnesium and ferrous iron however, (Mg^{++} = 0.78 Å, Fe^{++} = 0.83 Å) permits ferrous ions to substitute for magnesium in magnesium sites throughout the whole range without appreciably affecting the structure. Kulp, Kent & Kerr (1951) made an extensive study of carbonate minerals, and reached the following conclusions:. . . page 658 " 'Dolomite' with less than one per cent Fe_2O_3 is rare, and 'Ankerite' with a simple Mg: Fe ratio of 1 : 1 is uncommon. Ankerites have been found in this study in which the iron in the magnesium positions ranges from 5 to 70%." . . . "The most striking thing about these data is the clear proof that substitution of Fe^{++} takes place exclusively in the Mg^{++} positions such that the sum of the modes of Fe^{++} and Mg^{++} is equal to the modes of the Ca present."

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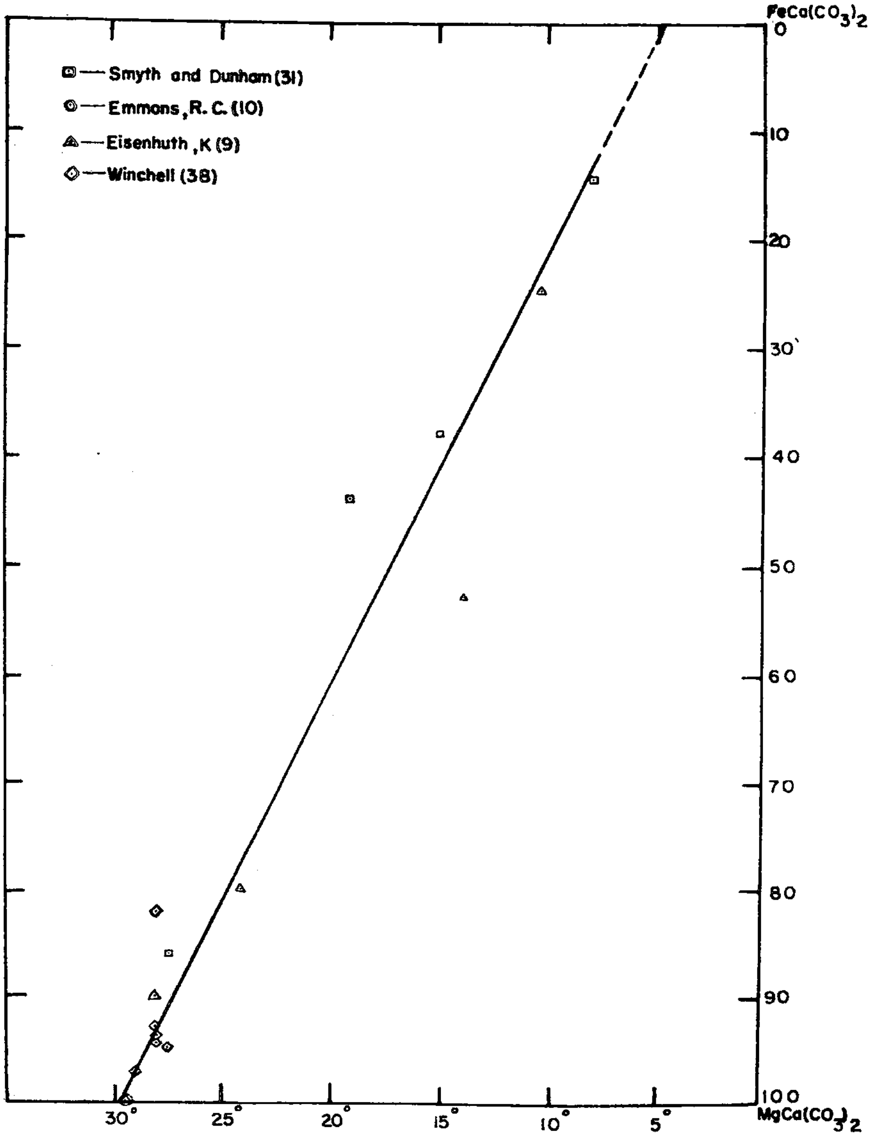

FIG. 1. Angle of rotation on the outer east-west axis required to change the transmitted ray of Dolomite-Ankerite from ϵ to ϵ', where $\epsilon' = 1.54$, which is the refractive index of Canada balsam.

Technique

A thin section of dolomite is mounted on the universal stage, using hemispheres with index of refraction 1.559 to permit direct reading, and a crystal of dolomite which is in contact with the Canada Balsam is selected and centred. The refractive index of the Canada Balsam is about 1.54 and this value falls between ω and ϵ for nearly all members of the dolomite-ankerite family. The crystal is oriented with the optical axis horizontal and north-south. In this position the transmitted ray has the index of ϵ which is lower than balsam. Rotation of the outer east-west axis changes this index in the direction of ω. As the rotation is made the Becke line is observed, and where the indices of the crystal and the balsam agree, the angle of rotation is noted. Errors in orientation are minimized by selecting only grains for which readings are obtainable by rotating the outer east-west axis in both directions. This angle of rotation is related to the refractive indices of the crystal, and therefore can be used as a direct measure of chemical composition.

Figure I is a curve relating this angle of rotation to the chemical composition of members of the dolomite-ankerite series. The points in this curve were calculated from data published by Eisenhuth (1902), Emmons (1943), Smyth & Dunham (1947), and Winchell (1951), page 114.

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DIRECT COLOUR PRINTS FROM POLISHED AND THIN SECTIONS

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Light passed through polaroids set at transmission right-angles has long been used for the study and identification of sectioned mineral in rocks. True photographic reproductions of the subtle interference colours produced has been difficult to achieve because of the many variables in