Lawsonite Equilibria

The plots on figure 1 show encouraging correlation with field observations. Three critical assemblages are commonly observed:

lawsonite-calcite-albite,

lawsonite-aragonite-albite.

lawsonite-aragonite-jadeite-quartz.

8

12

This sequence indicates increasing pressures of metamorphism. If we assume that temperatures of glaucophane schist metamorphism are of the order of 200-300°C (Brown, Fyfe, and Turner, 1962), the relative stability fields in figure 1 are in the correct order. Coombs (1960) has observed lawsonitecalcite; Ghent (ms), the association lawsonite-aragonite-albite; and McKee (1962), the transition from lawsonite-albite to lawsonite-jadeite-quartz. It should be noted that much of the common jadeite of glaucophane schists contains significant amounts of diopside and acmite in solid solution which may significantly lower the pressure of formation. There is thus an excellent correlation between calorimetric data, direct experiment, and field observation.

ACKNOWLEDGMENTS

This work was supported by the Petroleum Research Fund of the American Chemical Society and the National Science Foundation.

REFERENCES

- Barany, R., 1962, Heats and free energies of formation of some hydrated and anhydrous sodium- and calcium-aluminum silicates: U. S. Bur. Mines Rept. Inv. 5900, p. 17.
 Barany, R., and Kelley, K. K., 1961, Heats and free energies of formation of gibbsite,
- kaolinite, halloysite, and dickite: U. S. Bur. Mines Rept. Inv. 5825, p. 11. Brown, W. H., Fyfe, W. S., and Turner, F. J., 1962, Aragonite in California glaucophane
- schists, and the kinetics of the aragonite-calcite transformation: Jour. Petrology, v. 3, p. 566-582.

Clark, S. P., Jr., 1957, A note on calcite-aragonite equilibrium: Am. Mineralogist, v. 42, p. 564-566.

Coombs, D. S., 1952, Cell size, optical properties and chemical composition of laumontite and leonhardite, with a note on regional occurrences in New Zealand: Am. Mineral-

Coombs, D. S., Ellis, A. J., Fyfe, W. S., and Taylor, A. M., 1959, The zeolite facies with comments on the interpretation of hydrothermal syntheses: Geochim. et Cosmochim. Acta, v. 17, p. 53-107. Crawford, W. A., and Fyfe, W. S., 1964, Calcite-aragonite equilibrium: Science, v. 144,

p. 1569-1570.

Davis, G. A., and Pabst, A., 1960, Lawsonite and pumpellyite in glaucophane schists, north Berkeley Hills, California; with notes on the X-ray crystallography of lawsonite: Am.

Jour. Sci., v. 258, p. 689-704. Fyfe, W. S., and Valpy, G. W., 1959, The analcime-jadeite phase boundary: some indirect deductions: Am. Jour. Sci., v. 257, p. 316-320.

Ghent, E. D., ms, 1964, Petrology and structure of the Black Butte Area, Hull Mountain and Anthony Peak Quadrangles, Northern Coast Ranges, California: Ph.D. thesis, Univ. Calif., Dept. Geology and Geophysics.

Graf, D. L., 1961, Crystallographic tables for the rhombohedral carbonates: Am. Mineral-

ogist, v. 46, p. 1283-1316. Gray, D. E., co-ordinating ed., 1957, American Institute of Physics Handbook: New York, McGraw-Hill Book Company, 1524 p.

Jamieson, J. C., 1953, Phase equilibrium in the system calcite-aragonite: Jour. Chem. Physics, v. 21, p. 1385-1390.

Kawano, Yoshinori, and Aoki, K., 1960, Some anorthite bearing basic volcanic rocks in Japan: Tohoku Univ. Sci. Repts., ser. 3, v. 6, p. 431-437.

p. 454-455.

Kelley, K. K., and King, E. G., 1961, Contributions to the data on theoretical metallurgy: U. S. Bur. Mines Bull. 592, 149 p.
King, E. G., and Weller, W. W., 1961a, Low temperature heat capacities and entropies at 298,15°K of diaspore, kaolinite, dickite and halloysite: U. S. Bur. Mines Rept. Inv. 5810, p. 1-6. 1961b, Low temperature heat capacities and entropies at 298.15°K of some

sodium- and calcium-aluminum silicates: U. S. Bur. Mines Rept. Inv. 5855, p. 1-8.

Larsen, E. S., and Berman, Harry, 1934, The microscopic determination of the non-opaque minerals, 2d ed.: U. S. Geol. Survey Bull. 848, 266 p.

Latimer, W. M., 1959, Oxidation Potentials, 2d ed.: Englewood Cliffs, New Jersey, Prentice-Hall, Inc., 392 p. MacDonald, G. J. F., 1956, Experimental determination of calcite-aragonite equilibrium

relations at elevated temperatures and pressures: Am. Mineralogist, v. 41, p. 744-756.

McKee, Bates, 1962, Widespread occurrence of jadeite, lawsonite, and glaucophane in central California: Am. Jour. Sci., v. 260, p. 596-610.
 Newton, R. C., and Kennedy, G. C., 1963: Some equilibrium reactions in the join CaAl₂Si₂O₈-H₂O: Jour. Geophys. Research, v. 68, p. 2967-2983.
 Rossini, F. D., Wagman, D. D., Evans, W. H., Levine, S., and Joffe, I., 1952, Selected values of chemical thermodynamic properties: [U.S.] Natl. Bur. Standards Circ. 500, 1268 p.

Sharp, W. E., 1962, The thermodynamic functions for water in the range -10 to 1000°C and 1 to 250,000 bars: Univ. Calif., Lawrence Radiation Lab., UCRL-7118, 51 p.

Zen, E., 1961, The zeolite facies: an interpretation: Am. Jour. Sci., v. 259, p. 401-409.

270