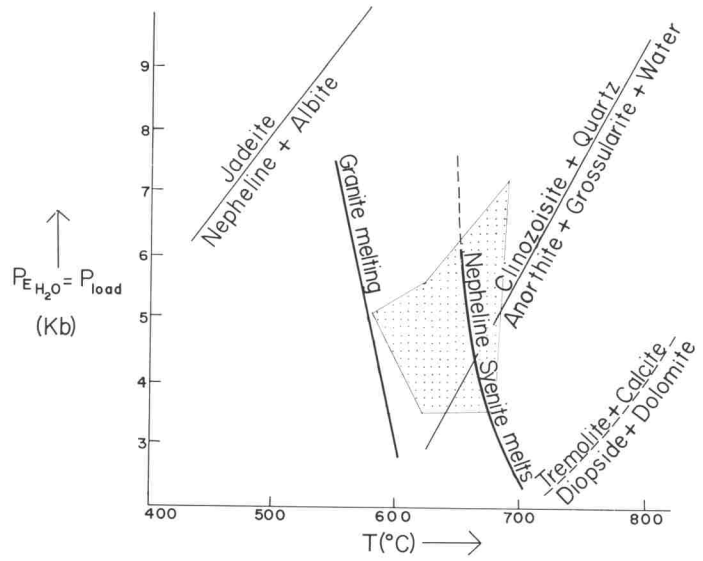

Fig. 5. Additional mineralogical equilibria pertinent to the Haliburton Highlands. The dotted area represents extremal conditions of formation for the Glamorgan rocks. Sources of reaction curves are as follows: Robertson et al. 1957 (Jadeite = Nepheline + Albite); Holdaway 1966 (Clinozoisite + Quartz = Anorthite + Grossularite + Water); Wyllie & Tuttle 1964 (minimum melting curve of granite in presence of Li_2O); Millhollen 1970 (minimum melting curve of nepheline syenite). The equilibrium Tremolite + Calcite = Diopside + Dolomite was calculated by the method of Turner 1967.

The effect of increasing the fugacity of oxygen to values greater than those appropriate to the QFM buffer used by Richardson will probably not increase the pressure-temperature limits of the field in which staurolite and cordierite may coexist (Richardson 1968, p. 485). The presence of MgO in staurolite will probably broaden this field (Richardson 1968, p. 484), but by an amount that is not as yet, predictable.

Some consequences of the proposed limits

The proposed limiting conditions of metamorphism for Glamorgan township have now been widened to 3.5 to 7 kilobars and 580 to 700 °C. If these are reasonable limits, certain predictions can be made by reference to other mineralogical equilibria (Fig. 5).

For example, clinozoisite may be used as a model for epidote, and Holdaway's (1966) breakdown curve for clinozoisite-quartz can be taken as an upper limit for this assemblage, since in the pressure range of interest here, it occurs at higher temperatures than either Newton's (1966c) version of the curve, or Merrin's (1962) curve for epidote- (33% iron component) quartz. From Fig. 5, it would appear likely, therefore, that epidote-quartz would be a stable assemblage in Glamorgan township. This is in fact, the case.

It would further be expected that anatectic granitic melts could have

been produced in this area. Evidence that this happened has been presented elsewhere (Chesworth 1969). It might also be suggested that some (at least) of the nepheline-syenites in the region could have arisen by anatexis. A detailed study of this possibility remains to be made. Certainly the assemblage nepheline-albite is, and should be, found in the nepheline syenites of Glamorgan township (Fig. 5).

Finally, and using the method of Turner (1967), a curve for the reaction Tremolite+3 Calcite=4 Diopside+Dolomite+CO_2+H_2O was calculated, no doubt with a large uncertainty. However, it can be used to suggest the possible stability of the assemblage calcite-diopside-tremolite in marbles in the area. Again, this fact is confirmed by field observation.

The conditions deduced therefore appear to be consistent with the mineralogy of Glamorgan township as a whole. They appear also to be consistent with conditions deduced for the rather similar metamorphic assemblages found in parts of the Pyrenees. Hess, for example, estimates pressures between 4.0 to 4.5 kilobars for the central Pyrenees.

Conclusion

Metamorphic assemblages in rocks from Glamorgan township in the Haliburton Highlands show resemblances with those of amphibolite facies rocks in both the Scottish Highlands and the Abukuma Plateau. This would indicate that metamorphism in this part of the Grenville province is of Miyashiro's (1961) low pressure intermediate type.

A metamorphic grid, set up on the basis of three field observations, suggests that conditions of formation fell within the load pressure range 3.5 to 7 kilobars, and the temperature range 580 to 700 °C. This spread of conditions is consistent with other field data for which there is equivalent experimental evidence.

Acknowledgements. – I would like to thank Dr. D. M. Shaw and D. J. Jennings for their help and advice. This work was financed by the National Research Council of Canada.

REFERENCES

Adams, F. D. & Barlow, A. E. 1910: Geology of the Haliburton and Bancroft areas, Province of Ontario. *Geol. Surv. Canada Mem. 6*, 419 pp.

Armstrong, H. S. & Gittins, J. (in press): Geology of Glamorgan and Monmouth townships, Haliburton County. *Ont. Dept. Mines Geol. Rept.*

Althaus, E. 1967: The triple point andalusite-sillimanite-kyanite. An experimental and petrologic study. *Contr. Mineral. and Petrol. 16*, 29–44.

Althaus, E. 1969: Experimental evidence that the reaction of kyanite to form sillimanite is at least bivariant. *Am. Jour. Sci. 267*, 273–7.

Best, M. G. 1966: Structural geology of Precambrian rocks south of Bancroft, Ontario. *Can. Jour. of Earth Sci. 3*, 441–55.

Bowen, N. L. 1940: Progressive metamorphism of siliceous limestone and dolomite. *Jour. Geology 48*, 225–74.

Chesworth, W. 1968: A comparison of Grenville and Lewisian granites. *Mineralog. Mag. 36*, 379–82.