AGE CONSTRAINTS ON THE EVOLUTION OF THE QUETICO BELT, SUPERIOR PROVINCE, ONTARIO; J.A. Percival and R.W. Sullivan, Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario K1A 0E8

Much attention has been focussed on the nature of Archean tectonic processes and the extent to which they were different from modern rigid-plate tectonics. The Archean Superior Province (1) has linear metavolcanic and metasediment-dominated subprovinces of similar scale to Cenozoic island arc-trench systems of the western Pacific (2), suggesting an origin by accreting arcs (3,4). Models for the evolution of metavolcanic belts in parts of the Superior Province suggest an arc setting (4,5) but the tectonic environment and evolution of the intervening metasedimentary belts are poorly understood. In addition to explaining the setting giving rise to a linear sedimentary basin, models must account for subsequent shortening and high-temperature, low-pressure metamorphism (6-8). Correlation of rock units and events in adjacent metavolcanic and metasedimentary belts is a first step toward understanding large-scale crustal interaction. To this end, zircon geochronology has been applied to metavolcanic belts of the western Superior Province (9-13); this study reports new age data for the Quetico metasedimentary belt, permitting correlation with the adjacent Wabigoon and Wawa metavolcanic subprovinces.

The 10-100 km-wide Quetico belt extends at least 1200 km from beneath cover in the west to the Kapuskasing structure and probably continues 800 km further east, as the Opatica belt. It is mainly fault-bounded against adjacent metavolcanic rocks but stratigraphic contacts are present locally. The belt consists of marginal zones of metasedimentary schist and an interior zone of migmatite and granite. Marginal metasediments have preserved sedimentary structures suggesting a homogeneous sequence of turbiditic greywacke, possibly derived from adjacent volcanic highlands (14). Conglomerate and cross-bedded sandstone of the Seine Group (15) occur sporadically along the northern margin of the belt and have been interpreted as proximal fan deposits of the Quetico turbidites (16) or as a younger sequence (15,17).

The most prominent structural features of the belt are the regular east-trending bedding which dips steeply near the margins and moderately in the interior, and a pervasive, gently east-plunging lineation. Several early sets of folds have been recognized in detailed studies (18-20). Symmetrical low-pressure metamorphic zonation characterizes marginal schists, where grade increases from chlorite-muscovite at the margins, through biotite, staurolite, and garnet-andalusite zones, to garnet-cordierite-sillimanite grade adjacent to the interior zone of migmatite and intrusive granite. Common assemblages of garnet-andalusite throughout marginal schists and locally in the interior indicate low metamorphic pressure (bathozone 2; 3.3 kbar (21)). Granulite facies occurs in the east near Flanders Lake (22) and adjacent to the Kapuskasing zone (23), where metamorphic pressure is 4-6 kbar (24). The regional metamorphic culmination is coincident with interior plutons, suggesting that the granites transmitted heat to high levels in the crust.

Plutonic rocks, classified into three compositional groups, have restricted spatial distribution: 1) a suite of small diorite-monzonite plugs cuts marginal schists and extends locally into adjacent metavolcanic belts; 2) biotite-magnetite leucogranite with local tonalite and amphibolite inclusions, occurs near the schist-migmatite contact; and 3) peraluminous granite, with garnet, cordierite, muscovite, sillimanite, apatite and tourmaline, are prevalent in the interior zone, particularly the Sturgeon Lake batholith (8). Late pegmatites are ubiquitous in the interior zone and common in the higher-grade parts of the marginal schist unit.

QUETICO BELT, SUPERIOR PROVINCE

Percival, J.A. and Sullivan, R.W.

U-Pb zircon geochronology in the Wawa subprovince indicates major volcanic activity between 2749 and 2696 Ma (25) followed by D_1 deformation at about 2696, deposition of alkaline ("Timiskaming") volcanics at 2689, D_2 deformation, and intrusion of post-tectonic plutons at 2684 Ma (9) to 2668 Ma (26) (Fig. 1). In the Wabigoon subprovince, volcanics were erupted in the interval 2755-2702 Ma, with post-tectonic plutons younger than 2695 Ma (12) (Fig. 1).

A chilled porphyritic dacite sill cutting biotite-grade Quetico metasediments yielded an imprecise U-Pb zircon date of 2743 ± 16 Ma, providing a minimum age for sediment deposition. A single tonalite clast from metaconglomerate at Max Creek, interpreted to be Seine equivalent, has zircons dated at 2684 ± 10 Ma, interpreted as the age of the source pluton. Together these dates show that the Quetico metasediments and Seine Group are not facies equivalent. Monazites from the geologically oldest plutonic rock type, a foliated biotite granite with zircons with relict cores, are discordant, with an upper intercept of 2684 Ma. Monazite from massive peraluminous granite with probable inherited zircon is concordant at 2670 Ma. Zircon and monazite from a pegmatite dyke form a discordia line with an upper intercept of 2671 Ma (Fig. 1). The data do not permit definition of the length of time of sediment deposition nor is the thickness of the sequence known; thus inferences on lithospheric thickness (28) cannot be made.

Preliminary synthesis suggests that sediment deposition on extending crust forming the Quetico basin probably occurred during volcanism in adjacent terranes, possibly continuing until volcanism ceased. Closure of the basin during D_1 and/or D_2 events, dated in adjacent belts, led to folding of the sedimentary pile and thickening of the weak crust. Conglomerates were deposited adjacent to marginal transcurrent faults. During subsequent thermal relaxation, partial melts were extracted from lower crustal metasedimentary and tonalitic rocks in a crustal root zone as well as from the mantle. The derived granites and diorites ascended passively to within 10 km of the surface, producing a regional low-pressure aureole in the host schists. A back-arc or inter-arc setting is favoured over an accretionary prism environment for the Quetico sediments because of its symmetry and high-temperature metamorphism which probably occurred in a region of high heat flow.

REFERENCES

1) Goodwin, A.M. et al. (1972) Geol. Assoc. Can. Sp. Pap. 11, 527-623.
2) Hamilton, W. (1979) U.S. Geol. Surv. Prof. Pap. 1078, 345 p.
3) Langford, F.F. and Morin, J.A. (1976) Am. J. Sci. 276, 1023-1034.
4) Blackburn, C.E. (1980) Geoscience Canada 7, 64-72.
5) Blackburn, C.E. et al. (1985) Geol. Assoc. Can. Sp. Pap. 28, 89-116.
6) Pirie, J. and Mackasey, W.D. (1978) Geol. Surv. Can. Pap. 78-10, 37-48.
7) Thurston, P.C. and Breaks, F.W. (1978) ibid, 49-62.
8) Percival, J.A. et al. (1985) Geol. Surv. Can. Pap. 85-1A, 385-397.
9) Corfu, F. and Stott, G.M. (1985) Inst. Lake Superior Geol. 32 (abstr.), 15-16.
10) Turek, A. et al. (1984) Can. J. Earth Sci. 21, 457-464.
11) Davis, D.W. and Edwards, G. (1982) ibid 19, 1235-1245.
12) Davis, D.W. et al. (1982) ibid 19, 254-266.
13) Nunes, P.D. and Thurston, P.C. (1980) ibid 17, 710-721.
14) Ojakangas, R.W. (1985) Geol. Assoc. Can. Sp. Pap. 28, 23-47.
15) Lawson, A.C. (1913) Geol. Surv. Can. Mem. 40, 111 p.
16) Wood, J. (1980) Precambrian Res. 12, 227-255.
17) Poulsen, K.H. et al. (1980) Can. J. Earth Sci. 17, 1358-1369.

18) Kehlenbeck, M.M. (1984) Geoscience Can. 11, 23-32.
19) Borradaile, G.J. (1982) Precamb. Res. 19, 179-189.
20) Sawyer, E.W. (1983) ibid 22, 271-294.
21) Carmichael, D.M. (1978) Am. J. Sci. 278, 769-797.
22) Coates, M.E. (1968) Ont. Dep. Mines Geol. Rep. 68, 22 p.
23) Percival, J.A. (1985) Geol. Surv. Can. Pap. 85-1A, 1-5.
24) Percival, J.A. (1985) Geol. Assoc. Can. Abstr. Prog. 10, A48.
25) Turek, A. et al. (1982) Can. J. Earth Sci. 19, 1608-1626.
26) Krogh, T.E. and Turek, A. (1982) ibid 19, 859-867.
27) Davis, D.W. (1985) Personal communication.
28) McKenzie, D. et al. (1980) Earth Planet. Sci. Lett. 48, 35-41.

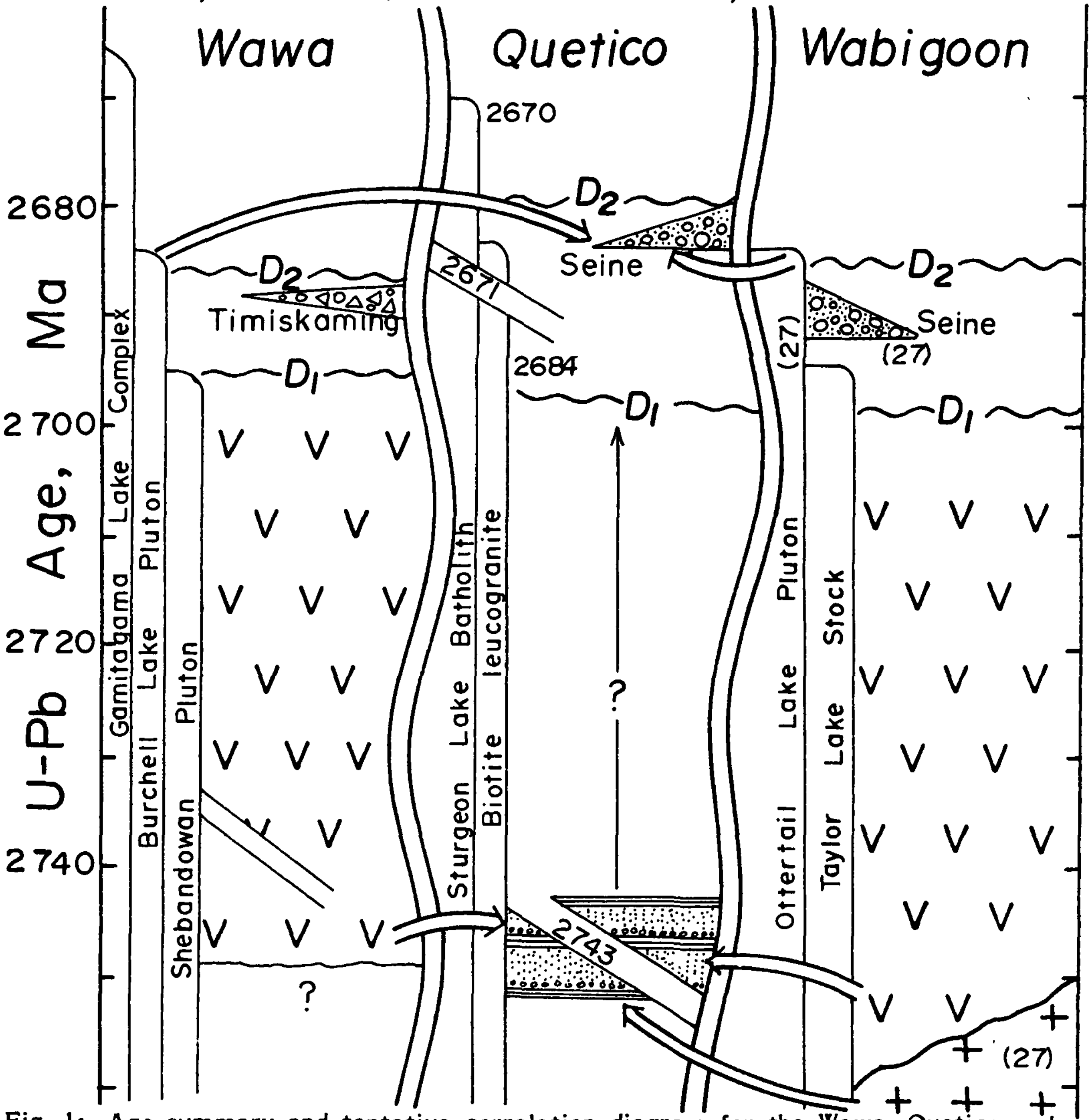

Fig. 1: Age summary and tentative correlation diagram for the Wawa, Quetico and Wabigoon subprovinces. Arrows crossing subprovince boundaries indicate sedimentary provenance.