STRUCTURAL VARIATION OF PROTEROZOIC DIKES IN THE CENTRAL SUPERIOR PROVINCE- A POSSIBLE REFLECTION OF POST-ARCHEAN SHIELD DEFORMATION, R. E. ERNST and H. C. HALLS, Dept. of Geology, University of Toronto, Toronto, Canada, M5S 1A1

Introduction

Geodynamic modelling of shield areas requires a 3-D understanding of the geology. In lieu of deep drilling and geophysical work, the third dimension is revealed wherever the crust is tilted to expose a vertical section at surface. However, the identification of surface exposure with changing structural depth is generally difficult in shield areas owing to their typically complex deformation. In areas where the structural and metamorphic patterns provide inconclusive results, data from post-orogenic diabase dike swarms may prove useful.

Undeformed mafic dike swarms of simple geometry cross-cut most shields. It has been suggested that their structural, paleomagnetic, and chemical characteristics can provide estimates of variation in exposure-depth throughout a shield terrain [1,2,3].

Preliminary work is reported below on the use of two structural parameters, dike dip and thickness, as possible depth-of-exposure indicators in the Central Superior Province.

Dike Dips

The dike dip data for the Central Superior Province divide into geographic domains of like dip (Figure 1). Domains of non-vertical dip may originate either because the dikes were intruded in a near vertical attitude and subsequently tilted along with the host terrain or because the contemporaneous stress regime or inherited mechanical anisotropy favoured non-vertical intrusion. While intrusion along an inclined plane almost certainly explains some of the scatter in our data, it appears that the dominant cause of regionally inclined dike-dips in the Central Superior Province is post intrusion deformation. This interpretation is based on the following observations: that, in general, dike orientation is unrelated to any obvious host rock grain, and more importantly, that the sense of dip in each domain is consistent with tilting of the host terrain as given by metamorphic, tectonic and paleomagnetic evidence (Figure 1, Table 1., [4,5])

Dike Thickness

The 3-D form of dikes is largely unknown but it has been speculated that dikes are vertically localized bodies which taper and pinch out with depth [1,6]. Therefore, progressive changes in dike thickness across or along a swarm may reflect differences in depth-of-exposure. However, this effect may be overprinted or totally masked by true lateral variation in dike thickness, resulting from variations in the elasticity of the host rocks or in the characteristics of the rising magma.

Preliminary dike-thickness data are available for the Central Superior Province and these data also appear to reflect host-rock erosional level (Figure 2); the average thickness of 2.6 Ga. dikes varies inversely with host rock metamorphic grade. Average thicknesses of less than 9 meters are found in

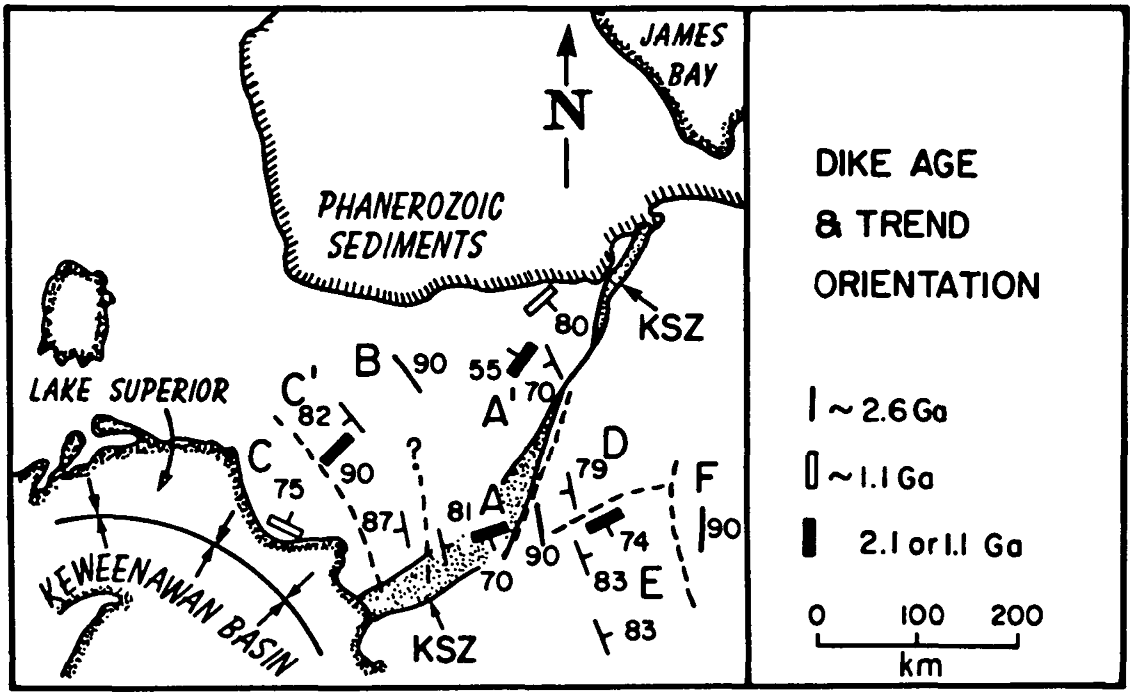

Figure 1. Dike Dip Domains in the Central Superior Province. Descriptions of each domain given in Table 1. Details of dip data given in references [3,5]. Number associated with each dike symbol gives the dip in the direction indicated by the dash. No dash indicates vertical dip. Underlined values based on 5-23 individual dike measurements, and the others 1-4 measurements. The average standard deviation for each determination is 7 degrees.

Table 1 DIKE DIP DOMAINS

Domain	Interpretation (according to model of post-intrusive deformation)
A	Block tilting uplift around NNW hinge line with detachment along the eastern margin of the Kapuskasing Structural Zone (KSZ)[8].
A'	Sparse data; non-vertical dips probably reflect block tilting associated with the KSZ
B	Outside zone of influence of KSZ
C	Associated with sagging of volcanic-laden crust of the Keweenawan Basin [9,10]
C'	These dikes are possibly located on the distal side of a peripheral bulge associated with down warping of the Keweenawan Basin.
D	Implies horizontal to shallow eastward dipping crust-the regional metamorphic grade also decreases in an eastward direction ([11] and Figure 2).
E	Implies shallow westward tilt of crust- perhaps results from dip slip movement along some of the numerous NNW-SSE striking faults which traverse this area. Northern boundary with D coincides with location of the large Abitibi dike shown in Figure 2, suggesting local emplacement of the dike along a fault. In this regard, it is interesting that although the dike appears to pinch out towards the SW, its extrapolated extension coincides with a KSZ boundary fault. We may speculate whether emplacement of this dike allowed detachement and differential movement of domains D and E together with renewed KSZ uplift at 1.1 Ga. or whether the fault was active earlier and simply reused by the dike at 1.1 Ga.
F	Outside zone of influence of KSZ

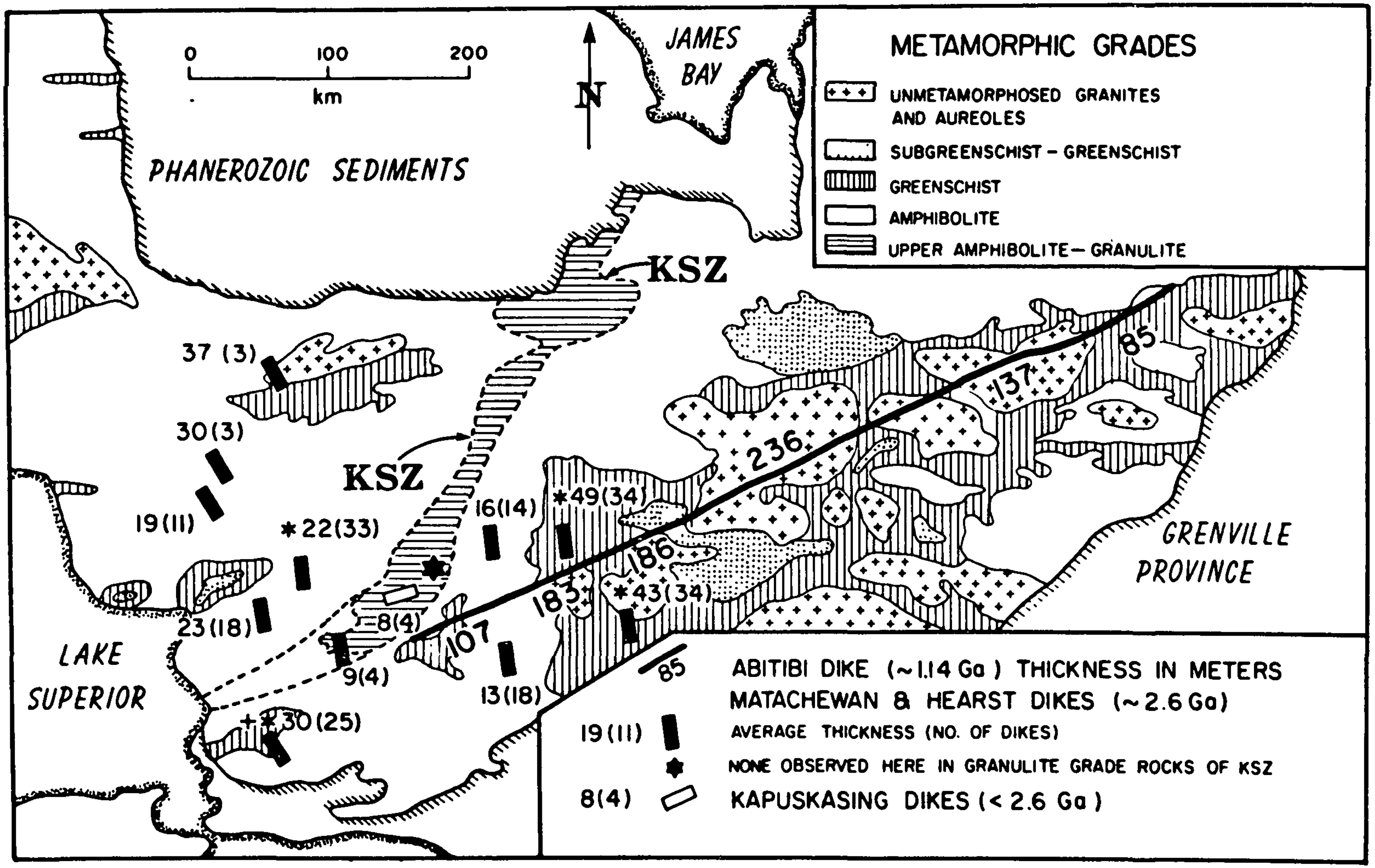

Figure 2. Regional Pattern of Dike Thickness in the Central Superior Province. The rectangular boxes give the generalized dike trend. Associated with each is a number giving the average dike thickness in meters and in parenthesis the number of dikes on which this is based. A star (*) indicates measurements made using outcrop data from published maps [13, 14, 15, 16]; the remaining average thicknesses were determined in the field from roadside outcrops. The datum marked with a plus (+) is from possible post 2.6 Ga. dikes. The standard deviation of each determination is about 10 meters. No correlation was observed between dike thickness and host rock type. The generalized metamorphic pattern is from references 11 and 12. The age quoted for the Abitibi dike is a preliminary unpublished U/Pb determination (E. Nakamura & T. Krogh, pers. comm., 1983). Numbers beside the Abitibi dike give its local thickness in meters. Note the inverse correlation of dike thickness with host rock metamorphic grade for dikes of 2.6 and 1.14 Ga. age.

the upper amphibolite to granulite zones of the Kapuskasing Structural Zone (KSZ) and in particular, no 2.6 Ga. dikes are observed in the granulites [7]. These data contrast sharply with those from outside of the KSZ; average thicknesses of 16 to 30 meters occur within amphibolite grade rocks and values of 30 to 50 meters in host rocks with a greenschist to subgreenschist grade. Similarly, the Abitibi dike is thickest (240 m) where the surrounding rock is sub-greenschist to greenschist and thins towards areas where the regional host-rock grade is greenschist to amphibolite (Fig. 2).

These dike-thickness data can be modeled by a post 2.6 Ga. uplift of the southern part of the KSZ [8], and a post 1.14 Ga. upwarp of the east and west margins of the Abitibi Subprovince.

Conclusion

The above data demonstrate systematic variations in the dip and thickness of 2.6 and 1.14 Ga. dikes across the Central Superior Province and are tentatively interpreted to result from post intrusion deformation. Combination of these results with additional structural and paleomagnetic data from dikes of all ages may permit detailed mapping both spatially and temporally of crustal deformation in this part of the Canadian Shield.

Although dike dip and thickness data apparently reflect crustal exposure level as given by host rock metamorphic grade (ranging from subgreenschist to granulite), these post-orogenic dikes themselves are at most only weakly metamorphosed. This requires that regional isotherms dropped dramatically after the Kenoran orogeny (2.65 Ga.) and prior to emplacement of the earlist post-orogenic swarm (Matachewan-Hearst) at 2.6 Ga.

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