On the paleoposition of North America in mid-Vendian through Cambrian time: A Restudy of the Sept Îles and Pointe du Criarde Intrusive Suites, Quebec, Canada

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Suggestions that Earth experienced large episodes of true polar wander during Vendian and early Cambrian time hinge both on the reliability of the underlying paleomagnetic data and the validity of the axial geocentric dipole hypothesis. In an attempt to assess the reliability of one of the critical middle Vendian directions for North America, that reported by Tanczyk et al. (1987), we conducted an intensive paleomagnetic re-sampling of the Sept Îles and Pointe du Criarde intrusive suites along the northern shore of the Gulf of St. Lawrence, near the town of Sept Îles, Québec. Tanczyk et al. identified a two-polarity, low-latitude component (termed 'A') from the Sept Îles intrusive suite, and a steeply-inclined two polarity direction (termed 'B') from it and from a newly recognized but younger intrusive complex now called the Pointe du Criarde intrusion. A subsequent radiometric U/Pb date indicates that the older intrusion was emplaced ~ 564+/-5 million years ago, whereas the earlier Rb/Sr age of approximately 540+/- 22 million years was actually obtained from the Pointe du Criarde intrusion. Although Tanczyk et al. reported results from a baked contact test which indicated that the 'B' component overprinted the 'A' direction, several authors have discarded this contact relationship and asserted that the 'B' component was most likely to be older, introducing an arbitrary tilt correction to bring it

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into concordancy with other 600 to 580 Ma results from Laurentia.

Our results confirm the exclusive association of the low-latitude 'A' component with the older Sept Îles mafic intrusion, and the presence of steep-inclination components in both intrusive complexes. Some fraction of these steep components are clearly associated with a viscous overprint of recent origin with high thermal stability, which was unrecognized in the previous analysis, but a high-stability 'B' component remains nevertheless, occasionally overprinting the 'A' component. The presence of flat-lying Ordovician limestones capping a central part of the intrusive complex, as well as horizontally-layered crystal settling features in the Pointe du Criarde intrusion, argues against introducing a regional tilt correction on any of the components. As the limestones are part of an extensive area with low conodont alteration indices on the stable portion of the Laurentian craton, and all of our rock magnetic and petrographic investigations have failed to find any evidence of secondary magnetic minerals, we find no support for the hypothesis that the 'A' component might be an overprint of late Ordovician age. Furthermore, U/He data from apatite in the Sept Îles complex indicate no heating at depth from mid Cretaceous time onwards; by comparison with the well-constrained APW path for North America this rules out a Tertiary age for the high-stability 'B' direction. We conclude that both the 'A' and 'B' components must predate Middle Cambrian time. Assuming that the Vendian and Cambrian Geodynamo was dominated by an axial geocentric dipole, these data support an equatorial position for Laurentia at ~564 Mry and a mid- to high-latitude position at ~540 Myr. Data from the earliest middle Cambrian Tapeats Sandstone indicate that it was back on the equator by about 510 million years ago. This is consistent with the hypothesis of Evans (1998) that there were multiple bursts of true polar wander during Vendian and Cambrian time, and is compatible with the suggestion that a double burst of TPW could enhance the methane storage and release which fueled the Cambrian evolutionary explosion (Kirschvink and Raub, in press).