
Tracking the Ministers Island dyke using marine magnetics, St. Andrews, New Brunswick

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The early Jurassic Ministers Island dyke is a quartz normative tholeiite coincident with extensional stresses related to the breakup of Pangea. The intrusion has an ENE-WSW trend, a near-vertical northern dip and outcrops at several onshore locations within northeastern Maine and southwestern New Brunswick. A map of the vertical magnetic gradient derived from a regional airborne survey flown in 2001 shows several kinks in the linear anomaly associated with the dyke, as well as an abrupt weakening and termination of the anomaly in the eastern part of Passamaquoddy Bay. With the objective of resolving post-early Jurassic movement along the dyke, a high-sensitivity marine magnetic survey was undertaken over the St. Croix River and Passamaquoddy Bay areas in August of 2005.

The survey was conducted using a Marine Magnetics SeaSpy total field magnetometer employing an Overhauser sensor. The instrument was towed approximately 1 m below surface and 24 m behind UNB's 13 m fibreglass research vessel 'Mary O'. A sampling rate of 1 reading per second at a boat speed of ≈ 4 m/s provided measurements at intervals of approximately 4 m along each line. A DGPS receiver on the boat was used for both navigation and to provide input to the recording system that calculated the layback position of the magnetometer. Water depths measured by the ship's depth sounder, and temporal variations in the earth's magnetic field at a base station were also recorded for later use in data processing and interpretation.

Preliminary gridding of the magnetic data shows that the dyke exhibits an apparent sinistral offset of approximately 220 m along the Oak Bay fault in the St. Croix River. This represents, to our knowledge, the only direct evidence to date of post-early Jurassic movement along the Oak Bay Fault,

although the fault has long been cited as a possible source of ongoing low level seismicity in the region. We recognize, however, that the evidence is not entirely conclusive as it is possible that the dyke may have been offset at the time it was emplaced across the pre-existing Oak Bay Fault zone.

In Passamaquoddy Bay, the dyke's magnetic anomaly exhibits a distinct local kink towards the south where it crosses the Big Bay fault. Given the presence of a trench with a vertical drop of 25 m in water depth in this area, we speculate that the kink could be explained by the dyke subcropping farther to the south (provided its dip is locally southward). Eastward of the kink, the anomaly associated with the dyke weakens abruptly where it is offset 190 m to the north by what appears to be a subsidiary fault. This weakened portion of the anomaly extends another ≈ 1750 m to the east before disappearing. Previous workers have speculated that an eastward continuation of the dyke may appear on land 2–3 km to the north of the termination as a result of additional dextral faulting.

Work in progress includes the production of a first vertical derivative map which may reveal more subtle features associated with faulting and modeling of the Ministers Island dyke to gain information on its depth, thickness and dip orientation.