Inferring post-Jurassic movement of the Oak Bay Fault through acquisition and modelling of magnetic profiles across the Ministers Island Dyke in Brooks Cove, Maine, USA*

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The Ministers Island Dyke in southwestern New Brunswick trends ENE-WSW from eastern Maine across the St. Croix River, St. Andrews peninsula, Ministers Island and beyond into Passamaquoddy Bay. The dyke is a quartz tholeiite, approximately 180 Ma in age, and it crosses the near-perpendicular Oak Bay Fault beneath the St. Croix River. An aeromagnetic survey acquired in 2001 revealed a kink in the trend of the strong linear magnetic anomaly associated with the dyke beneath the river, and prompted re-evaluation of an earlier conclusion that all significant movement on the Oak Bay Fault had ceased prior to dyke emplacement. In particular, it has long been questioned whether elevated seismicity in the region is a result of recent movement along this fault.

In 2005, University of New Brunswick researchers conducted a higher resolution marine magnetic survey in the St. Croix River in an effort to confirm whether faulting has displaced the dyke. This survey delineated the dyke anomaly on the eastern side of the Oak Bay Fault, but the boat could not travel sufficiently far into the shallow waters of Brooks Cove, Maine, to define the dyke anomaly to the west. In 2016, a shallow-water marine magnetic survey was undertaken by kayak to acquire additional magnetic profiles that follow the coastline more closely.

The kayak survey was centered in Brooks Cove and spanned approximately 1 km on either side of the cove. A proton precession base station magnetometer was set up onshore, while the surveying Overhauser magnetometer was aboard the kayak. The surveying magnetometer collected readings once every second along lines approximately 50 m apart, while a Garmin GPS receiver, carried 2.5 m behind the magnetometer, recorded a position every two seconds. Preliminary gridding of the data into a magnetic field map shows dramatic weakening of the anomaly over a span of 100 m across the Oak Bay Fault – suggestive of demagnetization in the fault zone – as well as curving of the dyke anomaly on either side of the fault – suggestive of dextral offset of approximately 300 m. This dextral offset opposes sinistral displacement that has previously been inferred for the Oak Bay Fault based on older crosscutting relationships. Further investigations will include forward modelling of variations in dyke orientation, and depth to top across the fault constrained by measurements of remnant magnetization, magnetic susceptibility, and dyke width available from previous studies.

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