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Hello Harold,

Thank you for your email. I was successful in getting strontium data on the two hockey sticks and have the following to report.

Strontium isotope analysis was carried on both hockey sticks, the 'Jones' stick (MARC5205) and the 'other' stick (MARC5206). Strontium (Sr) isotopes (87Sr/86Sr) in biological material, such as tree wood, derive mostly from strontium that originates in the geology, soils and atmospheric sources in the area in which the tree grows. The strontium isotopes of rocks/geology is largely governed by its type and age (and the rubidium content), with older rocks - and by association the soils that may be derived from the breakdown of these rocks - having higher 87Sr/86Sr than younger rocks. The other major potential source of Sr within terrestrial plants (and animals) will derive from oceans and the marine environment, which has a consistent modern 87Sr/86Sr = ~0.7092 (Kuznetsov et al. 2012). Since the strontium isotope values change little as they are incorporated into a trees tissues, the 87Sr/86Sr of wood should broadly reflect the geographic origin of the tree when alive. Unfortunately, 87Sr/86Sr values of rocks and trees are not unique to a specific location, and depending on the type and age of geology can be found in multiple places around the world. Using the possible/suggested geographic location information provided by the oxygen isotope analysis report on these two hockey sticks, here we have measured the 87Sr/86Sr of the 'Jones' and 'Other' hockey sticks to help further determine the possible origin of the wood from which they were made.

A small wood sample from each stick was obtained at preexisting damaged areas along the bottom of the stick blades. These sampling sites looked to be the areas were previous samples for either radiocarbon dating and/or oxygen isotope analyses had been taken. The wood samples of approximately 50mg were prepared according to modifications of existing protocols for measuring strontium isotopes in plant material (Ryan et al. 2018). Briefly, this involved heating (ashing) the samples in clean quartz tubes at 550C for 24 hours, followed by chemical digestion and oxidation of residual organics in the ashed sample (1.3mg and 0.5 mg for MARC5205 and MARC5206, respectively) in 3ml PFA (Savillex) vials using distilled 16M nitric acid (HNO3, 1ml) + high purity 30% hydrogen peroxide (H2O2, 1ml) at ~100C for 24 hours. The resulting solution was dried down and 1ml of 8M HNO3 was added to each vial before being transferred to previously cleaned Sr extraction columns (1ml pipet tips fitted with a porous frit) containing Sr-Spec resin (Eichrom). After several washes with 8M HNO3, the Sr from the samples were eluted into clean 2ml centrifuge tubes with 2ml of ultra pure water (DI H2O at 18.2 MOhm) and then acidified with HNO3 to give a ~2% solution. Strontium isotope analysis was carried out on a Thermo Fisher Neptune MC-ICP-MS in the MAF laboratory of CREAIT at Memorial University. Operational parameters and the data collection procedure of the Neptune followed typically used methods (Madgwick et al. 2019). The strontium signal intensities (88Sr) for both hockey stick samples were relatively low (88Sr = 5.5V 'Jones' stick; 2.5V 'Other' stick), which is expected given the small sample sizes and the strontium concentration of natural woods (Poszwa et al. 2004). The corrected (using a SRM987 87Sr/86Sr = 0.710248 from McArthur et al. 2001) 87Sr/86Sr for the two hockey sticks were:

Jones Stick = 0.7090 (0.709004 +/- 0.000013)

Other Stick = 0.7109 (0.710919 +/- 0.000028)

These 87Sr/86Sr values are fairly ubiquitous within coastal environments and those were (marine derived) sedimentary rocks occur (e.g. limestone, dolomite), and are inline with bioavailable (i.e. obtained from plants and animals, and based on modelled data) 87Sr/86Sr reported in Southern Ontario and northern portions of upstate New York (Bower 2017, unpublished PhD, Memorial University; Bataille et al. 2020). As such, these values appear consistent with the geographic areas identified by the oxygen isotope analysis of the hockey sticks, however, a more refined interpretation would require a better understanding of the biologically available strontium isotope variation for these general areas.

Best,

Vaughan

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