Carbon^{14} Dating of Intertidal Tree Stumps, Roots, Peat and Shells on the Outer Islands of Mahone Bay, Nova Scotia

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Introduction

During the summer of 2004, coastal mapping was undertaken on the outer islands of Mahone Bay (Figs. 1 and 2). In the course of this mapping a number of wood and peat samples were collected for carbon^{14} (C^{14}) age dating (Table 1). The samples were submitted by Dr. R. R. Stea (retired), Nova Scotia Department of Natural Resources, for analysis at the Geological Survey of Canada Radiocarbon Laboratory. The samples were collected to provide site specific information (i.e. in the outer bay area) of past rates of relative sea level rise. Additional samples of wood and shell material

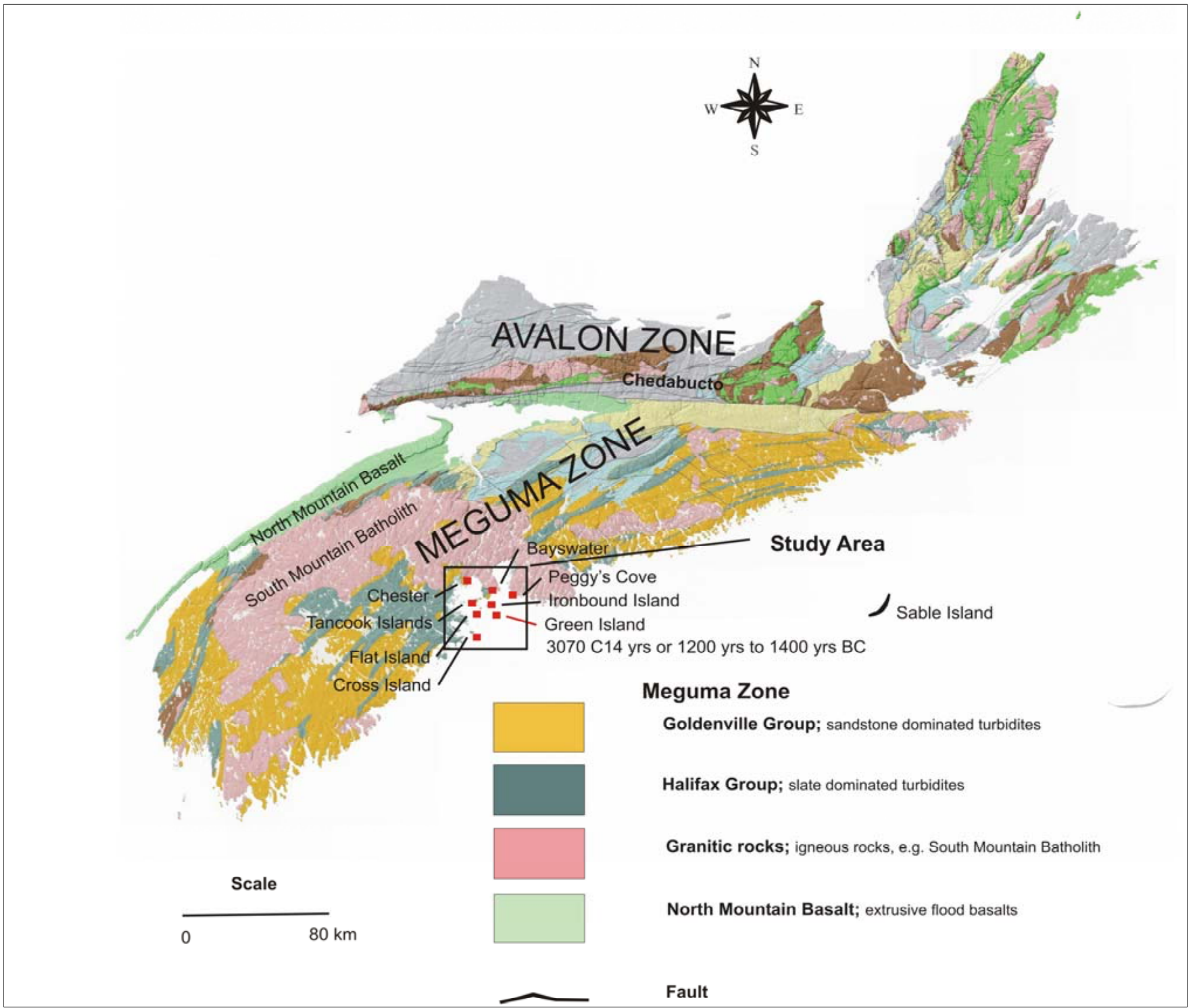

Figure 1. Simplified geology map of Nova Scotia showing locations of the islands.

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Table 1. Radiocarbon dates from wood, peat and shell material collected on the outer islands of Mahone Bay, Lunenburg County. Ages were corrected to years AD using Calib 6.0.0 and IntCal04 (0 – 26,000 yrs cal BP). Marine reservoir correction was carried out at the ANASTO Laboratory (Fink et al., 2004).

Location	Lab. No.	Sample Description	Depth Below HHWL	Radiocarbon Age	Corrected Age (AD)	Median	Years Pre- 2010
Big Duck	GSC-6869 Big Dk. - 1	In-situ stump in peat under beach gravel	0.2	270 +/- 60	1460 - 1690	1535	475
Cross Island	GSC-6864 Cross - 1	Peat underlying large driftwood log	0.9	360 +/- 60	1440 - 1650	1545	465
Cross Island	GSC-6865 Cross - 2	In-situ tree root in peat underly-ing beach gravel	1.1	490 +/- 50	1390 - 1490	1440	570
Pearl Island	GSC-6870 Pearl - 1	Till overlain in-situ root in peat under beach gravel	0.4	380 +/- 60	1440 - 1640	1490	520
Pearl Island	GSC-6871 Pearl - 2	Peat over bedrock on high cliff	n/a	990 +/- 50	970 - 1170	1070	
Flat Island Stump Cv.	GSC-6866 DNR - 1	In-situ(?) tree root in peat, sub-tidal	2.3	1260 +/- 50	670 - 900	735	1275
Flat Island Stump Cv.	GSC-6867 DNR - 2	In-situ(?) tree root in peat, sub-tidal	2.3	1530 +/- 50	420 - 620	520	1490
Flat Island Stump Cv.	GSC-6872 DNR - 3	In-situ tree root in peat, sub-tidal	2.1	1680 +/- 60	250 - 540	395	1615
Flat Island Stump Cv.	GSC-6873 DNR - 4	In-situ tree root in peat, sub-tidal	1.5	400 +/- 60	1430 - 1640	1515	495
Flat Island Stump Cv.	GSC-6874 DNR - 5	In-situ tree root in peat, sub-tidal	1.4	1080 +/- 50	860 - 1030	945	1065
Flat Island Stump Cv.	GSC-6876 DNR - 8	In-situ(?) tree root in peat un-derlying beach gravel	1.4	1630 +/- 50	320 - 550	335	1675
Flat Island	GSC-6868 DNR - 9	In-situ(?) wood (root?) in peat, sub-tidal	1	580 +/- 50	1290 - 1430	1360	650
Flat Island	GSC-6877 DNR - 10	In-situ tree stump in peat under-lying beach gravel	0.7	430 +/- 50	1410 - 1630	1520	490
Flat Island	OZL329	Marine shell in paleosol overlain by dune sand	n/a	605 +/- 35	1300 - 1410	1355	
Flat Island	OZL330	Driftwood log underlain and overlain by dune sand	n/a	280 +/- 45	1470 - 1670	1570	
Flat Island	OZL332	In-situ intertidal tree stump in peat overlain by beach sand and gravel	n/a	1190 +/- 45	760 - 900	830	
Flat Island	OZL331	Intertidal tree root(?) in peat overlain by beach sand and gravel	n/a	445 +/- 45	1410 - 1520	1465	

*NSDNR abbreviated to DNR. GSC - 6878, DNR – 11: discarded as modern; GSC – 6875, DNR – 6: discarded since it has a extreme age range up to modern.

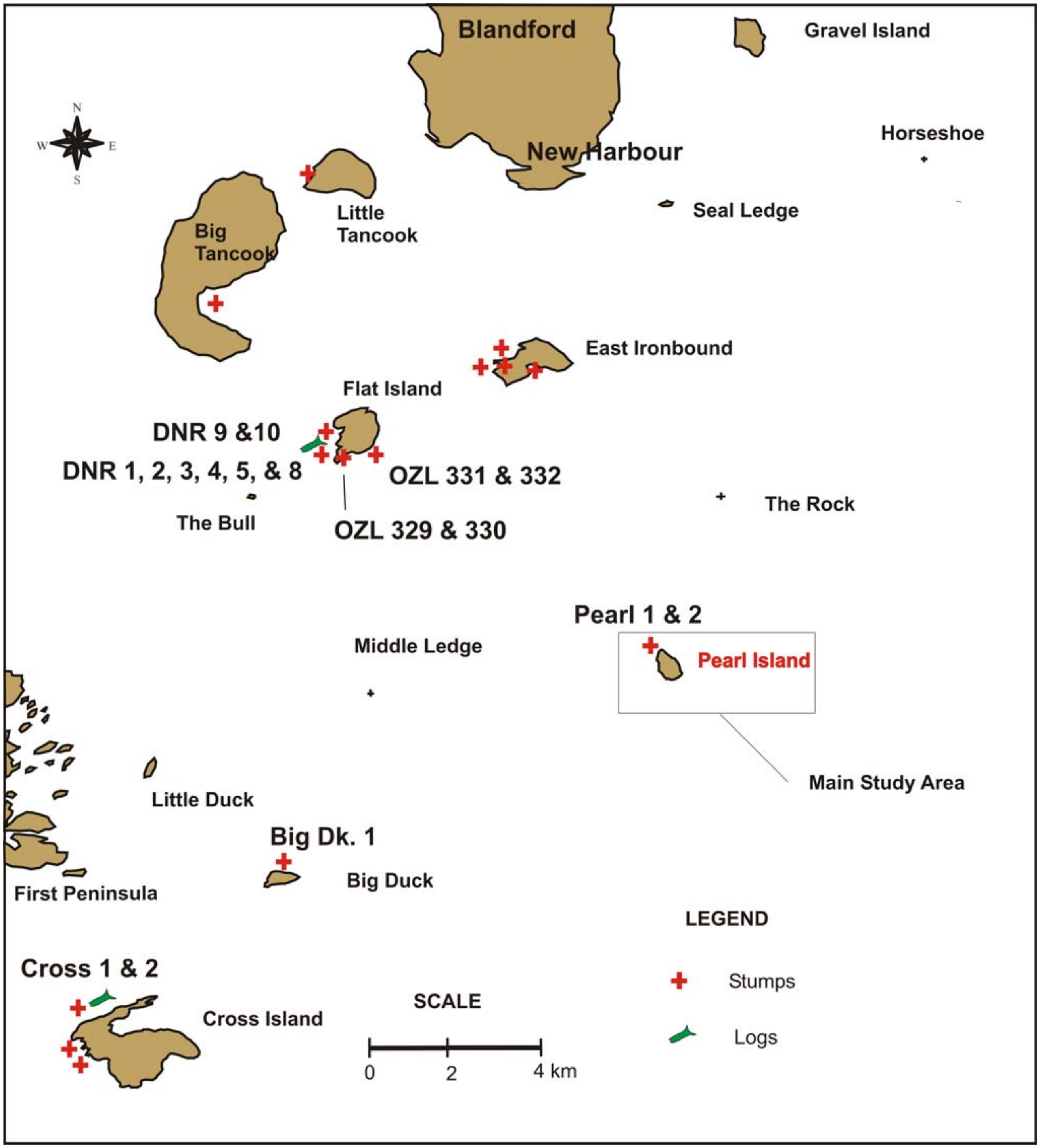

Figure 2. Location of samples from Table 1.

were collected during the summer of 2008 for the purposes of dating sand dune formation and coastal erosion rates. The additional samples were submitted to the Australian Nuclear Science and Technology Organization for C^{14} dating (Fink et al., 2004). Data for all samples are shown in Table 1. A map of the sample locations is shown in Figure 2.

Data Analysis

The primary purpose of this short paper is to release the results of the C^{14} dating. Two sea level curves are presented as a part of a preliminary analysis (Figs. 3 and 4). The data will be examined in further detail in a subsequent report. The data are colour coded, blue for samples collected for the purposes of dating sand dune formation and coastal erosion rates, green and orange for examining localized rates of sea level rise (Table 1). The two orange-coded samples are identified separately from the green as the distance below the high, high water line and/or the ages are anomalous in these samples. Thus results for these two samples are suspect.

Figure 3 shows a sea level curve based on a linear relationship over time. Given the relatively short period of time represented by the data, (i.e. approximately one millennium), a linear relationship is assumed. The curve (line) in Figure 3 is constrained by 12 data points (green and orange) and yields a rate of sea level rise of 11 cm/century with an R^2 value of 0.6. This rate is anomalously low compared to an average rate of 17 cm/century between AD 1000 and AD 1800, measured at Chezzetcook, Nova Scotia by Gehrels et al. (2005). The 11 cm/century rate is also significantly less than the rate of apparent sea level rise affected by isostatic subsidence of 15.7 cm/century to 17 cm/century calculated by Forbes et al. (2009).

Because of this problem, the data were re-examined and the two anomalous samples (outliers) shown in orange were removed. The resulting sea level curve (Fig. 4), yields a rate of apparent sea level rise of 16 cm/century with an R^2 value of 0.85. This value is in agreement with both Gehrels, et. al. (2005) and Forbes et al. (2009).

The results suggest that relative sea level change over the 1000 year period reflected in the data was controlled by isostatic subsidence with little eustatic control. It must be clearly noted, however, that the resolution of the data is insufficient to resolve periods of fluctuating sea level rise, such as during the Middle Ages Climatic Optimum or the Dalton Minimum (Little Ice Age).

For studies such as this it is important to put the data and results into perspective with respect to what they may mean at the present time. Gehrels et. al. (2005) noted that there was a sudden acceleration in the rate of sea level rise in the Halifax tide record data between AD 1900 and AD1920, to a 20th Century rate of relative sea-level rise of 32 +/- 0.13 cm/century (Forbes et. al., 2009). Gehrels et. al. (2005) suggested that the sudden acceleration was linked to the theory of climate change.

Readers should note that the acceleration in the rate of sea level rise was abrupt and occurred between 1900 and 1920 when global warming was minimal and well within the bounds of natural variability.

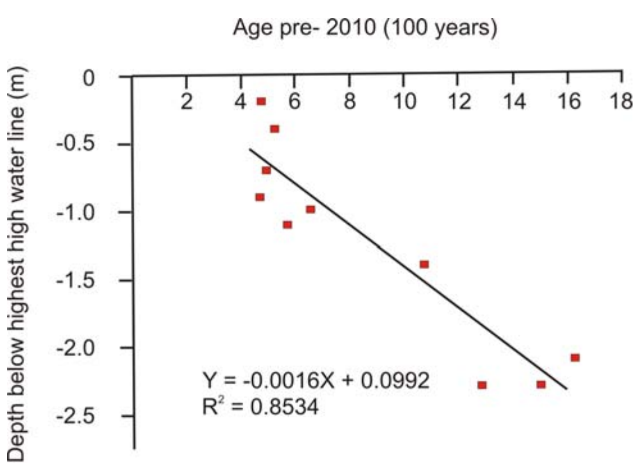

Figure 3. Sea-level rise curve for the outer Mahone Bay area with all data points included.

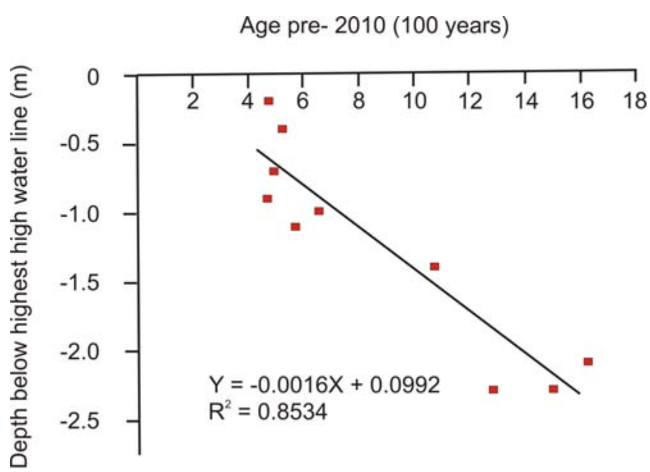

Figure 4. Sea-level rise curve for the outer Mahone Bay area with outlier data points removed.

There was also a negligible increase in anthropogenic CO_2 emissions at that time. Since then the amount and rate of increase of CO_2 emissions have increased dramatically. At the same time, sea level rise as measured by the Halifax tide gauge, except for short periods of time, has remained remarkably constant for almost 100 years. The abrupt acceleration in the rate of sea level rise at Halifax between 1900 and 1920 is inconsistent with the theory of global warming, climate change, or the newest term: global climate disruption. The fact that the rate of sea level rise since the early 1900s is constant is also inconsistent with the anthropogenic global warming theory. Additional studies are planned to examine these inconsistencies.

References

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