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Quartz OSL dating of late Holocene beach ridges from the Magdalen Islands (Quebec, Canada)

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ABSTRACT

Quartz optically stimulated luminescence (OSL) dating has been applied to sandy beach ridge systems from the Magdalen Islands in the center of the Gulf of St. Lawrence (Quebec, Canada) to provide the first chronological framework for these features. Nineteen beach ridges (22 samples) from four different sites throughout the archipelago were investigated. At one of the sites, samples were taken at 9 m and 7.5 m depth using a vibracore. The quartz is dominated by the fast OSL component and a single-aliquot regenerative-dose (SAR) protocol was used to measure the equivalent doses; a low preheat (180°C/10 s) was chosen to avoid the influence of thermal transfer. The average dose recovery ratio of all samples is 1.02 ± 0.02 ($n = 130$) suggesting that the SAR protocol works satisfactorily on this material. The OSL ages are internally consistent and supported by independent age control (radiocarbon). The OSL ages indicate that the ridges were built between 2.6 ± 0.2 ka and 0.40 ± 0.10 ka, i.e. during a period of sea level rise. This rise eroded adjacent sandstone cliffs, which contributed a significant sediment supply to the littoral drift and beaches. Some low-lying coasts in the archipelago are still prograding, despite a relative sea level increase of ~ 1.6 mm/a over the last 600 years. The late Holocene ages obtained in this study indicate that these processes have been active for at least the past two thousand years. This study demonstrates for the first time that OSL dating using quartz has great potential in this area, and is an appropriate method for establishing precise chronologies for coastal sediments in this region of the Gulf of St. Lawrence.

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1. Introduction

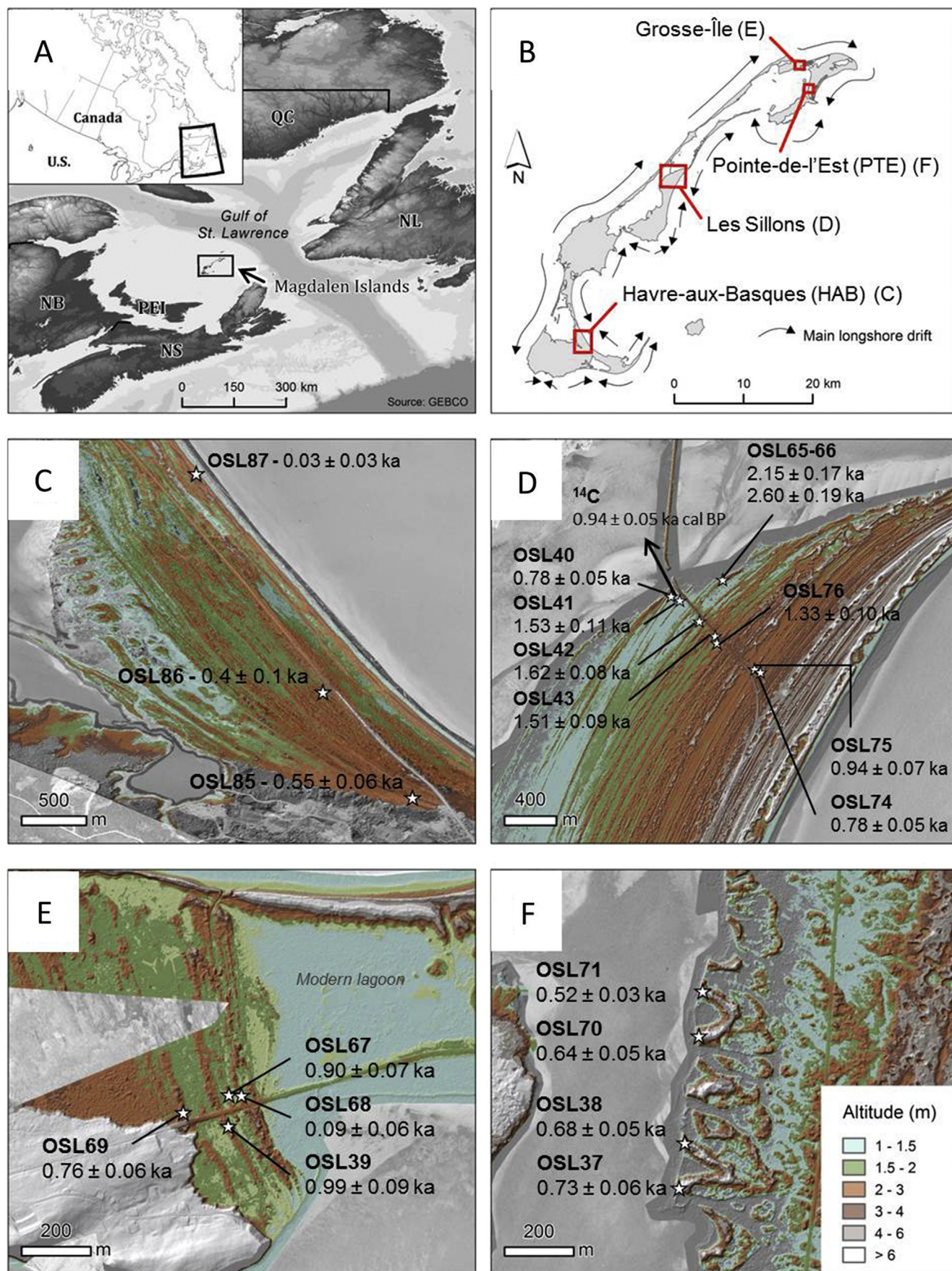
The Magdalen Islands lie in shallow water (<100 m) near the center of the Gulf of St. Lawrence, halfway between Prince Edward Island and Newfoundland in eastern Canada (Fig. 1A). Sandy beach ridges are found at five locations on the sandy causeway connecting the bedrock islands. Such beach ridge systems are regarded as providing a promising record of Holocene paleo-coastlines (e.g., Otvos, 2000; Scheffers et al., 2012). Here we use 'beach ridge systems' in the terminology of Scheffers et al. (2012) to describe the

different complexes of beach ridges, which can be of various morphodynamic origins (Taylor and Stone, 1996). These geomorphic features contain archives of the processes involved in the evolution of low-lying coasts, including records of sea-level, sediment supply, climate (including storm events and paleo-wind direction regime), wave energy and related littoral drift, etc. (e.g., Otvos, 2000, 2012; Bristow and Pucillo, 2006; Stutz and Pilkey, 2011).

On the Magdalen Islands, despite the presence of indicators of Holocene sea level changes, no local relative sea level (RSL) curve is available. Nevertheless, a RSL rise of 3 m over the last 2 ka has been suggested using an analysis of terrestrial environments and trees in living position, but now located in the intertidal zone (Juneau, 2012). This rise corresponds to an average of 15–20 cm/century in the last two millennia, with a peak of 34 cm/century during the last century. One consequence of this recent acceleration in sea level rise is that 70% of the coastline is currently at risk of erosion

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