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Geoarchaeology of the Burmarrad ria and early Holocene human impacts in western Malta

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ABSTRACT

Holocene sediments from the ria of Burmarrad (western Malta) provide a record of changing geomorphology, relative sea-level rise and human impacts. Chronostratigraphic evidence attests to a fluvial-dominated upper estuarine environment between ~7500 cal. BP and ~7000 cal. BP, with increasing salinity linked to rising post-glacial sea level. The shift to a marine setting is dated to ~7000 cal. BP, characterized by a wave-dominated coastline that accreted up until ~4000 cal. BP. During the maximum marine ingression, the Burmarrad floodplain formed a vast 1.8 km^2 marine bay, ~3000 m long by ~650 m wide, whose environmental potentiality presented western Malta's early societies with a multiplicity of coastal, terrestrial, and fluvial resources, in addition to a low-energy context favourable to the anchoring of boats. New palynological data show intensified human impact on the landscape beginning ~7300 cal. BP, which is broadly consistent with the earliest archaeological traces. Western Malta was already void of a significant vegetation cover by the mid-Holocene. Rapid human-induced sedimentation means that by the Bronze Age, the palaeobay had been reduced by ~40% compared to its mid-Holocene maximum. The final morphogenetic phase constitutes fluvial silts and sands that began accreting after 2700 cal. BP. During Punic/Roman times, the ria bay was ~1 km^2, and was flanked to the south by a well-developed deltaic plain providing fertile land for agriculture. Today, the ria is ~60% smaller than it was 7000 years ago.

1. Introduction

The Maltese islands (Malta, Gozo and Comino) constitute a group of small, low islands (highest point 246 m asl) situated in the Central Mediterranean, some 90 km south of Sicily and 350 km north of Libya (Schembri et al., 2009; Fig. 1). With a surface area of just 246 km^2, the archipelago's largest island, Malta, provides a unique laboratory to explore the geo-environmental problems linked to the evolution of civilizations in a Mediterranean island context (Guilaine, 1994, 2003). The island has a long and complex history of human use, stretching back at least ~7400 years cal. BP, when it was first occupied by societies from the island of Sicily (Bonanno, 1994). These settlers formed communities, developed agriculture and domesticated animals (Cassar, 1997). The island developed a rich Neolithic culture, most enduringly expressed by its megalithic architecture, and played an important role during the metal ages, Punic, Roman and Medieval times (Moscati, 1993; Sagona, 2002; Bonanno, 2005; Vella, 2005; Dalli, 2006; Bruno, 2009).

Despite Malta's rich archaeological record, very few environmental studies have been undertaken to probe the island's diverse sedimentary archives (Hunt, 1997; Gambin, 2005; Fenech, 2007), and our understanding of human land-use changes, climate and vegetation is poor. The prehistoric period in particular has been a source of vastly contradictory speculations (Guilaine, 1994), notably with regards to diffusionist versus autochthonous theories of cultural development. In this paper, we present new high-resolution data from the ria of Burmarrad, a ~1 by 2.5 km alluvial plain presently situated south of Salina Bay, where research has elucidated deep Holocene records conducive to high-resolution palaeoenvironmental study (Gambin, 2005).

1.1. Geomorphological context

Burmarrad is a 38.5 km^2 catchment situated on the western side of Malta (Fig. 2A). After Marsa, it constitutes the second largest watershed on the Maltese islands, with a 1.8 km^2 deltaic plain fed by three valley tributaries. The geology of the catchment is dominated by shallow marine carbonates of mid-Tertiary age (Hyde, 1955; Vossmerbäumer, 1972; Pedley et al., 1976) that are dissected by an intricate system of widiens, short Mediterranean-type watercourses that carry water during the wet season and flash-flood events (Anderson, 1997). The upland

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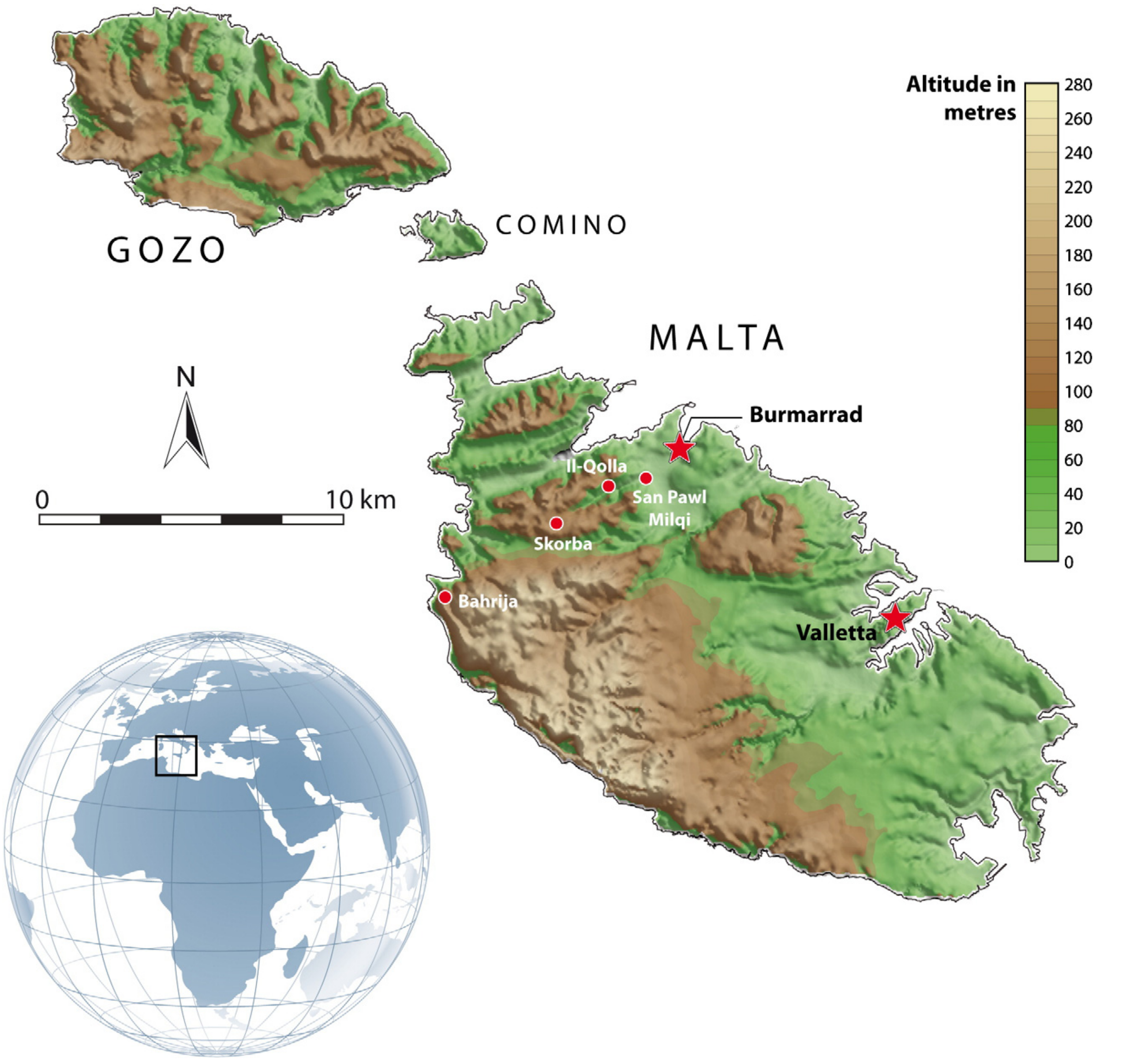

Fig. 1. Location map.

plateau (230 m amsl) is made up of the more competent beds of Coralline limestone while the lower reaches comprise Lower Coralline limestones, Greensand and Blue Clay Formations (Dart et al., 1993). This succession of limestone strata, interstratified with calcareous clay facies, is characterized by extensive faulting (Illies, 1981), with particularly high strain zones attested in the upland areas of the Burmarrad catchment (Putz-Perrier and Sanderson, 2010). Karstic phenomena, including small-scale lapis, solution features and cave systems are common (Guilcher and Paskoff, 1975; Paskoff and Sanlaville, 1978; Alexander, 1988).

The Burmarrad floodplain lies at the head of Salina Bay, a wave-dominated ria coastline governed by a micro-tidal wave regime of ~50 cm. The dominant longshore drift derives from the WNW (Paskoff and Sanlaville, 1978). At present the bay is particularly well sheltered by two limestone promontories that flank the eastern and western sides; the entrance to the embayment faces north-east. The permanently flooded marine basin area is presently 0.69 km^2 (Fig. 2B). The wind climate shows that only ~8% of the year is calm (Fig. 2A). The predominant wind is WNW, which on average blows on 16% of windy days (Schembri, 1997). The other wind directions, generally inferior to 6%, are nearly all equally represented. Severe winter storms arrive from the northeast (fetch of ~570 km). The maximum wave heights are >6 m and storms with waves above 4 m occur approximately eight times a year.

The overall geometry of Burmarrad's SW–NE trending valley has been governed by tilting and subsidence, leading to a submerged outer ria around Salina Bay. This contrasts with the pronounced elevation of the southern catchment area (Alexander, 1988; Putz-Perrier and Sanderson, 2010). Bed load sediment is supplied by three major fluvial systems: (i) the Wied il-Ghasel; (ii) the Wied Ghajn Rihana; and (iii) the Wied Qannotta. These watersheds are today heavily artificialized, with a shallow soil cover (20–60 cm) made-up of terra rosa soils, xerorendzinas and carbonate raw soils (Lang, 1960). In natural conditions, the soils are easily eroded under a climatic regime of long dry summers and a wet season in which rain frequently falls in heavy showers. At present rainfall averages 529.6 mm per annum and is characterized by a marked seasonal distribution, with ~70% of the total falling between October to March (Chetcuti et al., 1992). In many areas, the valley sides and floors have been eroded to bare rock.