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Geophysical investigations at the Anuru Bay trepang site: A new approach to locating Macassan archaeological sites in Northern Australia

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Introduction

This paper presents the results of a magnetometer survey and initial archaeological excavations of Macassan and Indigenous features conducted at the Anuru Bay Macassan trepang processing site. The archaeology of this area is complex, containing both material reflecting the Indigenous utilisation of coastal resources and the periodic visits of the Macassan trepangers from Indonesia.

Despite a history of archaeological investigations on Macassan period sites (i.e. Clarke 1994; McKnight 1976; Mitchell 1994), geophysical survey has not previously been applied as part of these investigations. While Macassan sites may contain features amenable to conventional archaeological geophysics (such as iron trepang processing pots), additional potential exists for the application of magnetometry to locate features created through burning, as has been applied to Australian Indigenous sites (Bonhomme and Stanley 1985; Fanning *et al.* 2009; Moffat *et al.* 2008 & 2010; Stanley & Green 1976; Wallis *et al.* 2008) and international Indigenous sites (Abbot & Frederick 1990; Batt & Dockrill 1998; Jones & Munson 2005). The results of this study demonstrate that this approach is equally applicable to Macassan sites, opening up a new and potentially fruitful avenue for exploring the archaeology of this trade system.

Background to the Study Area

Anuru Bay is a shallow coastal embayment in northwest Arnhem Land. The peninsula consists of a northern facing open sandy beach. The southern side of the peninsula, where the Macassan site is located, was formerly a sandy beach but is now characterised by extensive mangrove vegetation. Vegetation on the peninsula consists of sparse dune vegetation with *Eucalyptus miniata* (Darwin Woolly Butt), *Eucalyptus tetrodonta* (Stringybark) open forests with Sorghum grassland understorey and coastal mangrove forests.

The region is dominated by the massive sandstone escarpments of Mamadawerre Sandstone, part of the Kombolgie Subgroup (Carson *et al.* 1999; Rawlings 1999), that had a major influence on the coastal geomorphology of the region. The Anuru Bay area mostly comprises Quaternary regolith consisting of sand, silt, carbonate sediment and ferruginous laterite, the distribution of which reflects the complex environmental evolution of the area since the Pleistocene sea level rise stabilisation circa 6 000 to 8 000 BP (Needham 1984; Senior & Smart 1976; Sweet *et al.* 1999). The coastal and estuarine plains are developed mainly on estuarine sediments deposited in drowned river valleys and embayments that are seasonally inundated during annual wet season.

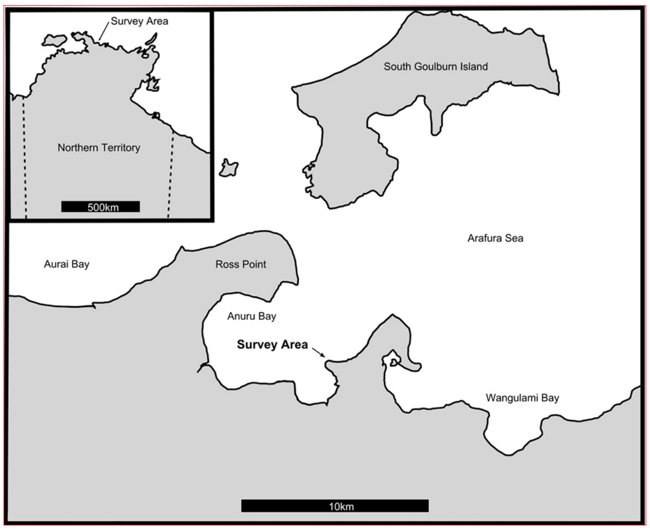

Figure 1. Anuru Bay site location.

A wide variety of Indigenous archaeological sites exist in the north-western Arnhem Land region including rockshelter occupation sites, rock art sites, artefact scatters, stone and ochre quarry sources, stone arrangements, and coastal shell middens and scatters. The earliest archaeological evidence for occupation of north-west Arnhem Land has been dated to at least 31 620 $\pm$ 350 calBP (R32137/3) based on radiocarbon dates from excavations of an Indigenous rockshelter in the Wellington Range.

Indigenous coastal resource extraction is well-

Figure 2. Aerial photograph of Anuru Bay (D. Wesley).

documented through a number of ethnographic and archaeological investigations along the Northern Territory coastal regions (Bourke 2000; Brockwell 2001; Meehan 1982; Mitchell 1994; Mowat 1994 & 1995). The majority of the Indigenous population of Arnhem Land was concentrated along the coastline to take advantage of the abundant local resources, which also provided one of the major routes for communication and interaction with other clan groups (Morphy 1991: 40). Shell species consumed in this region are diverse and abundant (Meehan 1982) and the archaeological evidence of this activity is likewise common and varied in nature (Clarke 1994; Bourke 2000; Roberts 1994). According to Davis (1985), Indigenous peoples have continued to use a diverse range of ecological resources, especially from the sea.

The Anuru Bay complex of Macassan archaeological features attests to a lengthy period of repeated occupation and possibly large numbers of Macassan trepangers (Macknight 1969 &1976). Previous investigation of the Anuru Bay Macassan trepang processing site by Macknight (1969 & 1976) documented a range of archaeological features associated with this marine extraction industry. Such features include 21 stonelines used for the boiling of trepang (some of which are now buried) running in a south-south westerly to north-north easterly direction. The stonelines are formed as single lines of stacked ferruginous sandstone rocks, with small bays for fire pits and scattered pieces of Macassan material culture including fragments of glass, ceramic, iron, brass and clay pipes. This site was likely abandoned by the Macassans by 1909 (Burningham 2000: 64; May *et al.* 2009: 370), and possibly much earlier as no record of it exists in official documentation (i.e. Searcy 1909).

The Macassan trade in the Northern Territory

Macassans voyaged to northeast Arnhem Land from Sulawesi in Indonesia in search of edible holothurians, commonly known as trepang or sea cucumbers (Schwerdtner Máñez & Ferse 2010). These annual visits to the north coast of Australia occurred over the last few centuries (*c.* 1700) until Australian government intervention stopped the Macassans in 1906. These visits had a profound impact on Indigenous culture and society (Mulvaney & Kamminga 1999) as reflected in the Indigenous archaeological record (Chaloupka 1993: 192). Three major trepang processing sites have been documented in the Northern Territory: Anuru Bay, Lyaba and Entrance Bay (Macknight 1976: 98).

Macassan occupation of the Arnhem Land coastline has been described as episodic; with voyagers taking advantage of the northwest monsoon winds in late December to reach Australia before returning to Indonesia with the southeast trade winds in March. Macknight (1976) estimates that this annual trade heightened during the nineteenth century, possibly involving between 30 and 60 *praus* (watercraft), each with an average crew of 30.

Macassans were known to establish trepang processing encampments along the Arnhem Land coastline to use as local base camps. These camps consisted of linear stone hearths for processing trepang via boiling in large pots. Trepang was then 'cured' by burying it in sand to decalcify it, and drying and smoking it in bamboo sheds (Pearson 2005: 49). Living arrangements for the workers at these processing sites consisted of building elevated wooden structures utilising materials from their *praus* (Macintosh 1996 & 2006). A ubiquitous archaeological feature of these sites is the linear 'stonelines' that provided a base for multiple trepang pot boiling. Several archaeologists have recorded evidence of these visits across northern Australia (see Clarke 1994, 2000a & 2000b; Clarke & Frederick, 2006; Macknight 1969, 1972, 1976 & 1986; May *et al.* 2009: 370; Mitchell 1994 & 2000; Mulvaney 1975 & 1989).

Magnetometry in archaeology

Geophysical techniques are widely used and have made considerable contributions to archaeological investigations worldwide (Clarke 1990; Weymouth 1986), although they have been only sporadically applied within Australia (Lowe 2012). Geophysical techniques can locate buried material, reveal site formation processes and define site boundaries (Witten 2006). Coastal areas of Arnhem Land such as Anuru Bay contain multiple periods of occupation and use through Indigenous camps and shell middens, Macassan resource extraction sites including trepang boiling stations, and sites of European activities. Magnetometery has great potential in such archaeological contexts due to its ability to detect areas of burning or heating, waste disposal, and industrial activities (Batt & Dockrill 1998; Frederick & Abbott 1992; Moffat *et al.* 2008, 2010 & 2011; Slater *et al.* 2000; Wallis *et al.* 2008).

The targets most amenable to geophysical investigation at the Anuru Bay site are areas of increased magnetism caused by cultural episodes of intense burning. The mechanism for anthropogenic burning causing magnetic enhancement of iron rich material through increased thermoremanence and the creation of more magnetically susceptible minerals has been extensively summarised elsewhere (i.e. Clark 1990; Aspinall *et al.* 2008). The

Figure 3. Magnetometer survey in progress (D. Wesley).

creation of a magnetic signature in this way has been validated by extensive control experiments (Carrancho & Villalaín 2011; Gose 2000; Linford & Canti 2001; Mclean & Kean 1993) suggesting that this is a robust strategy for archaeological prospection. While widespread anthropogenic burning of the landscape as a resource management strategy is practised in Northern Australia (i.e. Jones 1969), the increase in magnetic intensity accompanying hearths and campfires is likely to be higher (Belamo 1993; Linford & Canti 2001) and so these features will be distinctive.

Anthropogenic enhancement of the magnetism at the Anuru Bay site could include Indigenous and Macassan living spaces (i.e. hearths), industrial processing areas (i.e. smokehouse depressions, trepang boiling areas) and discarded ferrous objects (i.e. pots, axes, knives).

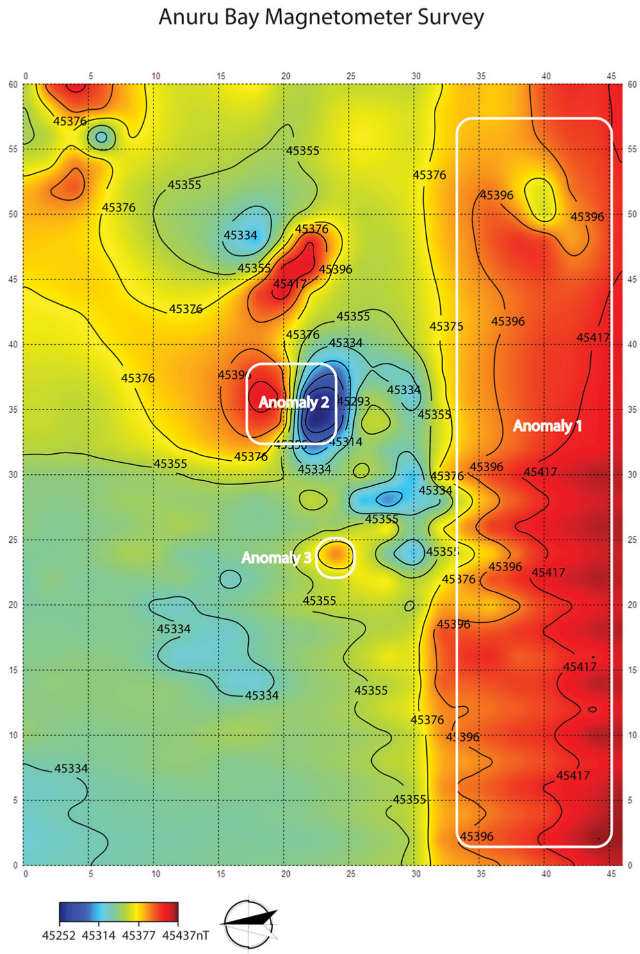

Figure 4. Map of magnetometer survey and magnetic anomalies (J. McKinnon).

Methodology

Geophysical investigations were conducted using a Geometrics G-856 single sensor proton precession magnetometer with data collected on a regular grid with 2 m line and station spacing in areas of the Anuru Bay site. Grid locations within this local grid were determined by stretching fibreglass measuring tapes between points on opposite ends of two baselines. These positions were relocated using measuring tapes for excavation, meaning that accurately locating them with RTK GPS or total station during survey was unnecessary. No diurnal correction was applied to the magnetometer data. Three surveys were conducted over the area including two 30 m by 30 m areas and one 60 m by 14 m area. All surveys were oriented on a north-south axis (x axis) by east-west axis (y axis). The data from these surveys were combined and further processed in Microsoft Excel to remove erroneous points where magnetic gradient was too high for robust results, gridded and presented as a contour plot using MagPick software.

Results

The magnetometer data showed a number of both discrete and diffuse anomalies that correlate to anthropogenic features known and investigated through previous and subsequent excavation (see Frederick & Abbott 1992 for a discussion on anomaly types). The most distinct is a monopolar anomaly (Anomaly 1) located on the southern edge of the survey area. This anomaly continues with a relatively lower signature and more diffuse boundary towards the eastern edge of the survey area. North of Anomaly 1 is a low magnetic intensity dipolar anomaly (Anomaly 2). West of Anomaly 2 is a slightly higher intensity and more discrete dipolar anomaly (Anomaly 3). These anomalies were selected for direct investigation on the basis of having the largest variation in nT value from background and not corresponding to features visible on the ground surface. Several other dipole anomalies exist including approximately 10 m to the east of Anomaly 2 and approximately 25 m to the north east of Anomaly 2, which correspond to isolated ferruginous sandstone on the surface and may reflect anthropogenic or weathering processes.

Direct investigation of geophysical anomalies

The distribution of Anomaly 1 coincides with a visible but discontinuous stoneline made of highly burnt ferrugenised sandstone. Within this feature, a test pit revealed stratigraphic units that consisted of dark, organic-rich, sandy silty soil, which is charcoal-rich with ashy lenses

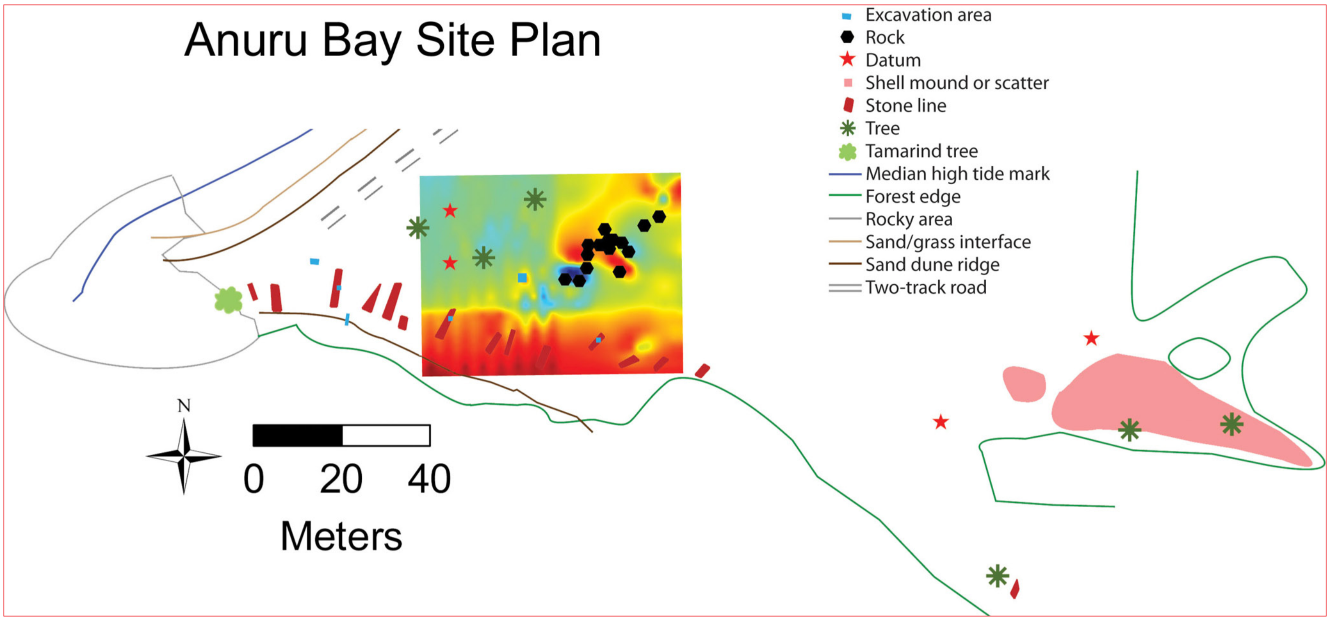

Figure 5. Site plan of Anuru Bay with magnetometer survey data overlay (J. McKinnon after J. Fenner).

and interspersed with shell throughout. Earthenware potsherds were also interspersed throughout the unit.

Anomaly 2, located to the north of the stonelines, was investigated by means of excavation. A 50 cm by 50 cm trench (T2) was emplaced on the anomaly. T2 was excavated to sterile soil and no significant anthropogenic features were identified during the excavation.

A stronger dipolar anomaly, Anomaly 3, located to the west of Anomaly 2 was also investigated by means of excavation. Anomaly 3 is located on top of the chenier ridge above the complex of stonelines and in an area of the Anuru Bay site complex that was subjected to limited investigation by Macknight (1976). A trench was opened at Anomaly 3, (T1-SQ1) to investigate the sub-surface deposit. The square revealed a densely packed shell midden layer immediately below the ground surface. The midden layer continued for 20 cm in depth and produced approximately 15 kg of shell. This midden layer contained the highest diversity and abundance of shell species from all of the trenches eventually excavated at Anuru Bay. The shell material was highly burnt and friable with ashy lenses interspersed throughout the deposit. At the base of the shell midden layer, a heat retainer hearth feature was found comprising five claystone rocks. The stones were deep red in colour indicating that they had undergone significant heating. Kaolinitic claystone in the Northern Territory will change colour from heat treatment owing to the presence of high levels of iron oxides.

The trench revealed three major stratigraphic units (Table 1). Samples for radiocarbon dating were collected at the base of the shell midden layer above the culturally sterile unit SU-III (Table 1). The calibrated basal date range, based on the SHCal 04 Southern Hemisphere calibration curve (McCormac *et al.* 2004), for the start of the midden accumulation is 1170–980. Therefore evidence for Indigenous occupation of the peninsula predates the known Macassan occupation by approximately 800 to 1 000 years.

Figure 6. Intact stoneline in the survey area (Photo: D. Wesley).

Figure 7. Heat retainer hearth feature (Photo: D. Wesley).

Discussion

The linear nature of Anomaly 1, the strong correspondence with the surface distribution of the stonelines and the lack of any other significant features during excavation suggests that this feature is caused by the presence of the stonelines. These results suggest the material has been subjected to anthropogenic firing, which has converted hematite and/or goethite emplaced during the laterisation process (i.e. Tardy & Nahon 1985) to maghemite or magnetite. The enhancement of the magnetic response of this stoneline is most likely due to its interpreted post construction use as a base for multiple trepang pot boiling. The 'sawtooth' nature of the northern boundary of this feature is attributed to operator error during survey, due to the regular offset of 2 m on each survey line, which is coincident with the station spacing.

Anomaly 1 depreciates in value towards the east. This reduction in magnetic signature may suggest a reduction of the density of the stones comprising the stonelines, or their dispersal and hence disruption of magnetic orientation (Bevan 1994; Moffat *et al.* 2011) due to post use disturbance.

The lack of a subsurface cause for Anomaly 2 is puzzling, however, it may be explained by the abundant rocks present in a haphazard arrangement trending northeast-southwest from the location of this feature to the northeast corner of the survey area. If these features are indeed the cause of this magnetic anomaly, they have likely been anthropogenically fired either by Macassans, Indigenous or post-contact inhabitants.

The enhanced magnetism of Anomaly 3 is interpreted to be the results of the hearth and/or the burning of shell in this area. The comparative small spatial extent of this anomaly suggests that the hearth is a more likely candidate for causing this feature.

Of further interest, from this survey is the comparatively high level of magnetic enhancement (approximately 50 nT) of the features compared to other similar Australian surveys (i.e. Moffat *et al.* 2008 & 2010; Wallis *et al.* 2008). This may be explained by the abundant non-magnetic iron oxides present due to weathering processes in Northern Australia, which are amenable for conversion to magnetic features through firing, suggesting that this area would be profitable for future surveys of this kind.

The magnetometer survey methodology used in this investigation, in which the relatively slow sampling rate proton precession sensor (one sample every three seconds for robust results) (Geometric Inc, 2007) and manual positioning were applied, proved suitable for defining features within a known site. This methodology is, however, probably too slow both in magnetometer sample rate and survey grid setup for the location of unidentified archaeological sites. The Arnhem Land coast is several thousand kilometres long, sparsely populated and an area potentially rich in archaeological heritage so techniques for rapidly locating new sites is of great interest. Further reconnaissance surveying for locating new sites would achieve results using a combined cesium vapour sensor (ten samples per second) (Geometrics Inc. 2001) and RTK-DGPS methodology (as outlined in Moffat *et al.* in prep.) which allows the operator to collect a density of data points while moving at an uninterrupted walking pace and does not require a site to be gridded with survey tapes.

Conclusion

Despite extensive survey of the location of Macassan trepang sites in northern Australia (i.e. MacKnight 1976) many questions remain in regards to the nature of the relationship between Indigenous occupants and Macassan visitors at these sites.

The results of a magnetometer survey at an Indigenous/Macassan archaeological site at Anuru Bay have been presented here in which the magnetometer survey located a number of significant anomalies, one of which was demonstrated to be a Macassan stoneline and another an Indigenous pre-Macassan hearth and burnt shell midden dated to 1170–980 calBP. The survey also located a number of isolated rocks, which appear to have been magnetically enhanced by firing.

Our results demonstrate that magnetic enhancement is an intrinsic component of Macassan and Indigenous sites in this region and so geophysical surveys can make a significant contribution to locating a range of buried features with minimal disturbance. While in this survey some archaeological features such as the stonelines were present on the surface, many Macassan sites likely remain buried on the extensive Arnhem Land coastline and may be located using geophysical techniques.

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