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Testing soil fertility of Prehispanic terraces at Viejo Sangayaico in the upper Ica catchment of south-central highland Peru

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ABSTRACT

This study presents a pilot geoarchaeological investigation of terraced agricultural systems near San Francisco de Sangayaico, in the upper Ica catchment of the Southern Peruvian Andes. It aims to assess the evidence for soil fertility associated with agricultural strategies practised throughout the Prehispanic, Spanish colonial and modern occupations in this region. A series of twenty-two test pits were hand excavated through two terraced field systems, and sampled to examine the changes in soil physical and chemical characteristics down-profile and downslope.

This study provides the first geoarchaeological analyses of the agrarian soil system surrounding Viejo Sangayaico in the upper Ica catchment. Results demonstrate that the soil system was much modified prior to the creation of the terrace systems, probably about 900 years ago. This system was characterised by a weakly acidic to slightly calcareous pH, a consistent but low electrical conductivity, reasonable-but-variable phosphorus content, and a loamy soil texture with a component of weathered volcanic tonalite parent material. The shallow terrace soil build-up on the slopes investigated indicates that slope modification was as minimal as possible. Moreover, the relatively low frequencies of organic material and phosphorus suggest that the terraces were not heavily fertilised in the past, making the stability and management of the nutrient-rich topsoil vital.

The results of these excavations and soil fertility analyses are situated within the context of the wider Andean ethno-historic and the archaeological record to address questions regarding how the terraces were built and maintained over time. Agricultural terraces undoubtedly mitigated the effects of slope erosion associated with cultivation. But, the terrace soil features observed at Sangayaico do not appear to be the same as those documented in other geoarchaeological studies of Andean terrace systems. These contrasts may be accounted for by a combination of differing geological substrate and hydrological conditions, as well as variable trajectories in past soil development, erosion factors, manuring/field management practises and crop selection.

1. Introduction

In this study the soil fertility of two Andean terrace systems and their associated buried soils adjacent to the archaeological site of Viejo Sangayaico (or SAN1) is assessed (Fig. 1). It is set within the Quebrada Marcaccarancca of the highland Olaya tributary of the Río Ica in the south-central Andes of Peru. The site and its environs including ancillary settlements cover *c.* 30 km^2 situated between 2800 and 4200 m.a.s.l., and were ethnically part of the Late Prehispanic Chocorvos 'nation' (Puglar, 1946). This site is dated to Late Intermediate, Inca and Spanish colonial periods with a range of radiocarbon dates from cal AD 1122 ± 81 (952 ± 27 BP; OxA-30914–6) to cal AD 1527 ± 88 (362 ± 27 BP; OxA-30930-1). It is located at the transition between the low-lying agricultural *quechua* ecozone (or irrigated, cultivated terrace zone at 2300–3500 m.a.s.l.) and the increasingly agro-pastoralist *suni* (or dry field agricultural zone at 3500–3800 m.a.s.l.) and *puna* ecozones (or upland pasture zone at 3800–4800 m.a.s.l.) (Covey, 2006; D'Altroy, 2003; Pulgar Vidal, 1946). The area exhibits significant technological investment in terracing and irrigation canals for agriculture on the mountain slopes of the *quechua* zone, and high altitude check dams in the high *puna* zone geared towards the creation of good pasturage. Viejo Sangayaico appears to have been situated so as to control access to and from these ecozones and across the northern Pisco Valley, an important hub of Chorcorvos (AD 1000–1450) and later Inca (AD 1450–1532) and Spanish (post-AD 1532) occupations (Bueno Mendoza, 2003; Chauca Iparraguirre and Lane, 2015; Huaman Oros and Lane, 2014; Lane et al., 2015). Although no direct dating evidence was retrieved from the palaeosols and terrace systems at Sangayaico, it is

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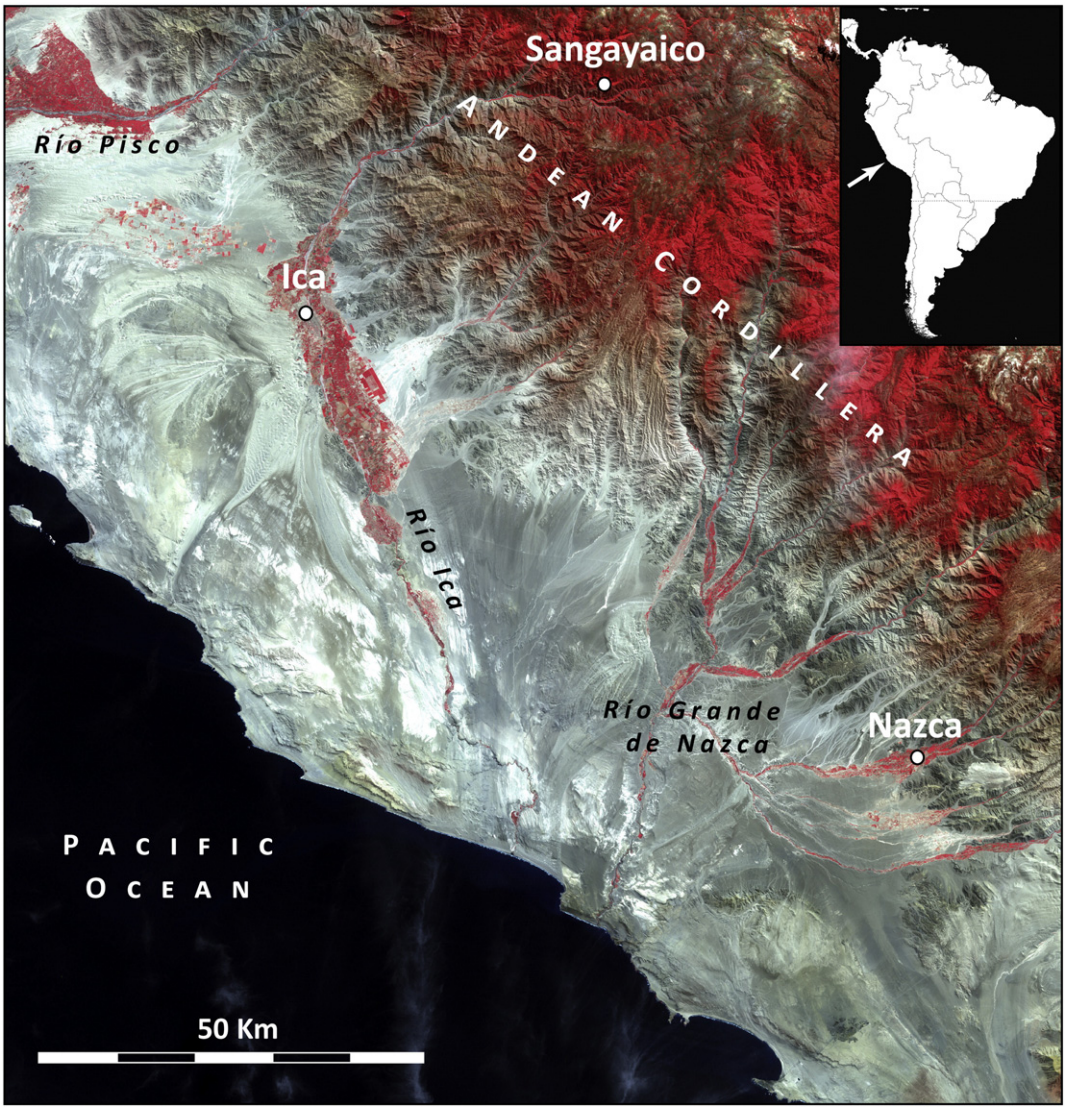

Fig. 1. Location map of Sangayaico in the upper Ica valley of southern Peru. D. Beresford-Jones, based on LANDSAT 7 ETM + 2000, USGS.

highly likely that the construction and use of the extensive bench terracing found in the area below *c.* 3500 m.a.s.l. relates to the same periods as the adjacent occupations recorded and radiometrically dated. Situated in an area rich in agricultural terracing, both abandoned and in use, this paper presents a preliminary assessment of soil fertility of part of the terrace system around the Sangayaico sites, as well as providing important comparative information concerning the creation and maintenance of terraces in the Andean highlands.

Geologically, the area is composed primarily of tonalite parent material originating from volcanic activity that occurred during the Cerozoic–Quaternary transition (Palacios Moncayo, 1994). Tonalite is primarily composed of andesine, biotite, hornblende, quartz, and orthoclase minerals (Nettleton et al., 1970). The weathering of biotite in tonalite produces clay particles such as kaolinite and vermiculite, as well as silicaceous mica, and hornblende and quartz weathering produces sand, silt and clay particles (ibid., 1970). It is these weathered mineral constituents that define the substrate characteristics of the landscape surrounding Sangayaico. Stone and coarse-fine sand-size fragments of this tonalite parent material are found throughout the soil materials composing the terrace systems. The regional soils developed on this parent rock range from luvisols with evidence of clay migration to weakly developed cambisols, with leptosols on the steeper, rockier slopes (Gardi et al., 2015; WRB, 2014).

Soil fertility analyses are a crucial tool in the characterisation of past and present agro-ecosystems (Sandor et al., 2007). Given the scale of human impact on the Andes (Denevan, 1992; Lentz, 2000), it is surprising that so few geoarchaeological studies of terrace systems exist in this geographical area, especially given the large amount of work that has been done on terraces more generally in Peru (i.e. Branch et al., 2007; de la Torre and Burga, 1986; Farrington, 1980; Gelles, 2000; Kemp et al., 2006; Kendall and Chepstow-Lusty, 2006; Kosok, 1965; Mitchell and Guillet, 1994; Schjellerup, 1986; Trawick, 2003; Treacy, 1994; Williams, 2006). This study goes some way to rectifying this gap in our knowledge and provides comparative soil fertility analyses across several agricultural systems, thus providing important insights on the interpretation of past agricultural strategies and other socio-cultural practises in the region (Goodman-Elgar, 2009; Sandor et al., 2007; Wells, 2006).

The many previous studies of terraces elsewhere in the Americas have suggested that there is firm evidence for terracing in the Preclassic Mayan period *c.* 2000 years ago, reaching a peak in the Late Classic period about 1300 years ago (Beach et al., 2015; Bonavia, 1967-1968;