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Basalt source characterization in the highlands of western panama using portable X-ray fluorescence (pXRF) analysis

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ABSTRACT

This paper assesses the utility of using portable X-ray Fluorescence (pXRF) to define basalt geochemistry in order to identify the sources of basalt tools in the western highlands of Panama during the Aguas Buenas period (A.D. 300–900). These data are expected to amplify our knowledge about the regional production and exchange of these items. The elemental composition of geological basalt samples and archaeological artifacts from two high elevation river valleys (Chiriquí Viejo and Chiriquí) are compared to analyze village–quarry relationships and to provide insight on a poorly understood topic. Our results indicate that sampled source areas are elementally distinct and allow us to differentiate between local and non-local basalts in archaeological samples. Combining this new information with earlier research on domestic organization confirms that the role of non-local basalt exchange varied within residential sites. However, our results do not indicate that this activity contributed clearly to the political development of the Barriles center.

1. Introduction

Archaeologists in southern Central America have increasingly turned toward the analysis of pottery, polished stone, marine shell and animal bone to infer the directions, tempo and intensity of pre-Columbian exchange networks (i.e. Cooke, 2004, 2005; Cooke et al., 2003; Iizuka, 2013). These studies demonstrate the deep antiquity of exchange and point toward the need to further understand the distribution of chipped stone artifacts. Andesites and basalts were the principal materials used to make chipped and polished stone tools in the western mountains of Panama between the Early Holocene and Spanish contact (Ranere, 1980; Palumbo, 2013; Sheets et al., 1980). Obsidians are present in this area (Ranere, 1980) but fine-grained basalts represented the preferred knapping material available to pre-Columbian inhabitants. The ubiquitous remains of basalt artifacts throughout archaeological sites attest to this importance, and the material was used to manufacture chipped stone tools as well as polished stone celts. Artifacts fashioned from jasper and rhyolite are also present in this region, but earlier research indicated that only basalt correlated with higher ranking domestic areas within Barriles (Palumbo, 2013). Barriles is commonly interpreted as an Aguas Buenas period (cal. A.D. 300–900) chiefly center (Künne and Beilke-Voigt, 2009; Linares et al., 1975; Hoopes, 1996, 2005; Palumbo, 2013). This paper considers the sources and distribution of basalt artifacts in further detail and represents the first published study of basalt artifact sourcing in southern Central America.

The principal advantage of X-ray Fluorescence (XRF) analysis is that it is non-destructive (Shackley, 2011). Because other sourcing techniques damage artifacts (e.g. thin sectioning) or require expensive instrumentation, archaeologists interested in production and exchange in southern Central America have relied upon stylistic and morphological similarities to infer contact between culture areas. Portable XRF units permit the rapid and relatively affordable characterization of metals and minerals. Sourcing studies in northern Central America and South America have increasingly used this technique to analyze obsidians (e.g. Cecil et al., 2007; Craig et al., 2007; Feinman et al., 2013; Kellett et al., 2013; Moholoy-Nagy et al., 2013; Nazaroff et al., 2010) and auriferous metal artifacts (e.g. Harrison et al., 2010). Basalt research remains relatively underdeveloped in Latin America. In other areas of the world, XRF analyses of basalts have generated enlightening results (e.g. Grave et al., 2012; Lundblad et al., 2008; Mills et al., 2011) and suggest that similar projects elsewhere might enjoy comparable success.

Understanding the sources and traffic of basalt in western Panama is important for two reasons. The first is that the Upper Chiriquí Viejo region of western Panama represents an unusual case in the regional literature. This area witnessed the development of a chiefly polity but, unlike other examples in southern Central America, this process involved the fewest items with identifiable origins outside of the local

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valley. This implies that the development of political hierarchy in this case was weakly connected to non-local exchange, but we require sourcing studies to evaluate this point. Researchers in southern Central America tended to emphasize how competition over the acquisition of trade items was central to political development (Creamer and Haas, 1985; Helms, 1979; Hoopes, 2005), although this is no longer a consensus view (see Cooke, 2004; Cooke et al., 2003; Fitzgerald, 1996). In the pre-Columbian chiefly polities of southern Costa Rica and western Panama, non-local artifacts are found on Isla del Caño (Finch and Honetschlager, 1986), in various Diquís Delta sites (Badilla et al., 1997; Corrales, 2000; Stone 1963), Drago (Wake et al., 2004), La Pitahaya (Cooke, 1980; Linares, 1968) and at Rivas (Quilter, 2004). These goods (e.g. decorated ceramics, possibly some greenstone and goldwork) had their origins in other culture areas. Exchange activities may have been important to the historic Coto chiefdom, probably centered at the Java site near the Costa Rica-Panama border (Fonseca and Chavez, 2003), owing to its position near the important *Camino de Mulas* trade route (Carmack and Salgado, 2006).

The second important reason is that many polished stone celts were crafted from basalt (Palumbo, 2009; Ranere, 1980). Scholars have suspected a relationship between celts and facets of social organization, particularly elite dominance. Some Barriles statues depict important individuals holding celts and decapitated human heads (Linares et al., 1975). Celts were common grave goods in the most conspicuous stone-lined tombs (Bernstein 1984). Researchers have also noted that celts and celt repair evidence are disproportionately restricted to larger sites in the settlement hierarchy (Linares and Sheets, 1980). Domestic sectors in Barriles exhibit a consistent and non-random spatial association between basalt manufacturing evidence, celts and unusually high proportions of Bugaba Engraved and Zoned Bichrome pottery (see Palumbo, 2009). Such highly decorated and finely made pottery is found in their very highest proportions in the core of Barriles, where sculpture depicting rank differences were located (see Hoopes, 1996; Vidal F., 1993). Bugaba Engraved pottery and the sculpture share some iconographic designs (Linares et al., 1975). Unusually high proportions of this ware are therefore suspected to reflect elevated domestic rank in this region (Palumbo, 2009, 2013).

The spatial association between basalts and domestic rank raise the possibility that the manufacture of celts and other stone tools underwrote incipient social ranking. Celts were tools that were increasingly in demand. Lake core evidence suggests that humans accelerated the slashing and burning of forest to plant corn and beans (Gallinat, 1980) during the first millennium A.D. (Behling, 2000; see Clement and Horn, 2001). Restricting the production or distribution of celts during this period would theoretically have limited the ability of agriculturalists to clear forest (among other tasks). Such a scenario might allow opportunistic groups to indirectly restrict access to basic subsistence resources, begin to create social debts between producers and consumers, and to thus to take the first steps toward accruing coercive power.

The source of basalts for the celts and other stone tools found in the Chiriquí Viejo study area region of western Panama is unclear. Cobbles suitable for knapping are available in streambeds adjacent to many archaeological sites and these were likely washed from outcrops upstream. This observation led Palumbo (2009) to stress the possibility that high ranking groups supported skilled artisans, rather than a raw material supply. Ranere (1980) argued that celt preforms were first manufactured at mountain quarry-workshops outside of the local region without chiefly influence, and that these were then imported to village settlements (see Linares and Sheets, 1980). This perspective finds support in investigations elsewhere in Panama where quarry-workshops sites have been identified (Drolet, 1980; Griggs, 2005). One example was the site of LP-10 in the central cordillera of the Coclé province, where the sheer quantity of basalt debitage, cores and preforms suggest that axes were being produced for subsequent trade (Griggs, 2005:245). These were probably carried or exchanged to villages as preforms (Haller, 2008), where specialists finished, and re-sharpened damaged tools. These were then used and maintained by individual households (see Menzies, 2009). The grave of one such specialist, containing polishing stones and axes, was identified at Sitio Sierra in Coclé (Cooke, 2005). Each scenario differs in its emphasis on where raw material was procured. If Palumbo's scenario is accurate, we expect that local basalt types should be well-represented in archaeological sites, particularly by celts, celt fragments and debitage. By contrast, the identification of many non-local examples lends support to Ranere's scenario. If stone artifacts can be clearly sourced to other regions, and these are non-randomly associated with higher ranking domestic sectors, then the case for the social importance of non-local exchange would be strengthened.

This paper reports the results of our pXRF analyses of 35 basalt artifacts and 17 natural streambed basalt nodules from the upper Río Chiriquí Viejo region. An additional 30 basalt artifacts from the India Vieja Baja quarry complex in the watershed of the Río Chiriquí are also analyzed (Fig. 1). The locations of suitable basalt sources are poorly known in this area of the world, so we first compare samples of naturally occurring streambed basalts found adjacent to archaeological sites to assess whether examples exhibit enough geochemical variability to discriminate between sources. We then compare artifact samples from two habitation sites and one quarry-workshop site to compare to this baseline geological information. We conclude by offering our thoughts on the relationship between non-local exchange and social organization in this area and outline the prospects for future XRF lithic sourcing studies in southern Central America.

2. Previous Research

2.1. Upper Río Chiriquí Viejo

The investigations led by Olga Linares, Charles McGimsey and Anthony Ranere (Linares, 1968, 1977; Linares and Ranere, 1980) were the first to transcend decades of localized collection projects in western Panama by modeling the relationship between different environments and social organization. These projects ultimately involved work in several regions of western Panama, but their investigations of the Chiriquí Viejo and Chiriquí highlands was the most sustained. Lying on the western flanks of Volcán Barú above 1200 m, the political center of Barriles (BU-24) was identified by earlier researchers (Ichon, 1968; Stirling 1950) and subsequent regional survey (Linares and Sheets, 1980; Linares et al., 1975) placed the site atop a hierarchy of non-monumental settlements that stretched 24 km along the length of the Río Chiriquí Viejo. Of particular importance are the two largest pre-Columbian villages, Barriles and Pitti-González, estimated to contain 500–1000 and 250–500 residents respectively (Palumbo, 2009). The earlier Concepción period (cal. 300 B.C.–A.D. 400), is represented by a few small and ephemeral sites (Palumbo, 2009). The Aguas Buenas period (cal. A.D. 300–900) witnessed the widespread settlement of the study area and 96% of the material sampled by Palumbo (2009) dates to this time. Only Barriles exhibits a sizeable Chiriquí period (cal. A.D. 900–1530) component (Linares and Sheets, 1980). Behling (2000) finds evidence for forest recovery and a sharp decline in maize pollens in lake core data following A.D. 1420, suggesting abandonment of the region in advance of Spanish Contact.

The Aguas Buenas period is divided into two phases, the Early Bugaba (cal. A.D. 300–600) and the Late Bugaba phase (cal. A.D. 600–900) (Palumbo, 2011; Spang and Rosenthal, 1980). The latter phase is the only clearly associated socially complex patterns, notably a regional settlement hierarchy, household differentiation and monument construction (Palumbo, 2013). Both the large residential sites of Barriles and Pitti-González contained higher proportions of lithic manufacture debris compared to hamlets and farmsteads, an observation that lends support to the view that villages were much more heavily engaged in stoneworking activities