

Chemical characterisation of obsidian from the Maya site of San José, Belize

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The authors use a social network analysis to map the changing patterns of obsidian supply among the Maya during the period of Classic to Postclassic transition. The quantity of obsidian received from different sources was calculated for 121 sites and the network analysis showed how the relative abundance of material from different sources shifted over time. A shift from inland to coastal supply routes was found that appears to have contributed to the collapse of inland Maya urban centres. The methods employed clearly have a high potential to reveal changing economic networks in cases of major societal transitions elsewhere in the world.

Keywords: Mesoamerica, Maya, Classic, Postclassic, third–fifteenth century AD, obsidian, social network graphical analysis, urbanism, systems collapse

San José, Belize

Archaeological investigations at the Maya site of San José, Belize, were conducted between 1931 and 1936 by Sir J. Eric. S. Thompson (then a curator at the Field Museum) under the auspices of the Field Museum of Natural History and Carnegie Institution. Thompson's initiative was to explore "one of the innumerable small sites" that dot the Maya countryside, with the innovative assumption that these sites are more typical of the general culture than larger regional centres (Thompson 1939: 1). The material excavated from San José was divided between the Field Museum, the Carnegie Institution and the Belize Estate and Produce

Company. Seventy pieces of obsidian from Thompson's excavations have been housed at the Field Museum since that time.

San José's central core (Figure 1) consists of four main groups, each centered on one or more plazas. The largest, Group A, is situated on a hilly outcrop, and consists of several temple structures rising approximately 13m off the Plaza floor. The second largest, Group C, contains a palace-type structure, ball court and several associated platforms and structures. Groups B and D are much smaller, comprising small multi-roomed structures with associated platforms and a large temple with a raised platform/plaza. "Numerous mounds" (probably house mounds) are noted to the north and south of the central settlement core of the settlement, but none of these were investigated (Thompson 1939: fig.1).

Thompson used stratigraphy to develop a chronological sequence at the site based on ceramic seriation (Thompson 1939). The phases he defined on this basis, labelled San José I–IV, roughly correspond to the Late Preclassic (San José I), Early Classic (San José II), Late Classic (San José III), late Late Classic (San José IV) and the Terminal Classic (San José V) as currently understood.

The San José obsidian assemblage

Thompson specifically targeted caches for collection and removal at San José. Of the 70 pieces in the Field Museum collection, 38 (54 per cent) are recorded as coming from caches (including burials), and we suspect that at least 12 additional pieces came from similar deposit types, based on their recorded location under doorways, in 'ash heaps' or in clusters. Thirty-two blades and flakes were chemically analysed by Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS), while all seventy obsidian pieces in the Field Museum San José collection were analysed by portable X-ray Fluorescence (PXRF) analysis (Table 1).

Method

LA-ICP-MS measurements of 52 major, minor and trace elements were made using a Varian Quadrupole ICP-MS housed at the Field Museum Elemental Analysis Facility (EAF), with sample introduction via a New Wave UP213 laser ablation system. Six external standards were run with each batch of samples: NIST610 and 612 glass standards, Brill's Corning B and D glass

standards, and Sierra de Pachucua and Glass Buttes obsidians (Glascock 1999). Concentrations were calculated after the method reported by Gratuze *et al.* (2001).

PXRF data were generated using an Innov-X Systems Alpha™ portable X-ray fluorescence device. In the present study, the fundamental parameters program supplied by Innov-X Systems™ was used to calculate concentrations, with the device set to the ‘soils’ mode. Ten minor and trace elements were measured. For both LA-ICP-MS and PXRF measurements, the comparability of results obtained at the EAF to published data was assessed by comparison to measurements obtained on the Glass Buttes and Sierra de Pachuca standard obsidians at other laboratories (Glascock 1999).

Results

Four chemical profiles were identified among the analysed obsidian pieces, labelled groups 1–4 (Figure 2). Comparison to published chemical measurements for sources in Central America (Carballo *et al.* 2007; Glascock & Cobean 2002; Glascock *et al.* 1990; www.obsidianlab.com) and a single source sample allow us to link Group 1, containing the majority of analysed pieces, to the El Chayal source in highland Guatemala. Similarly, group 2 (six specimens) obsidian pieces match the compositional profile for the Ixtepeque source in eastern highland Guatemala.

The high Rb/Sr ratios and low Mn/Fe ratios that characterise chemical groups 3 and 4 distinguish them from highland Guatemalan obsidian sources, and are consistent with published values for some central Mexican obsidian sources. Extensive chemical studies of these Central Mexican sources at Missouri University Research Reactor (MURR) by Instrumental Neutron Activation Analysis (INAA) has revealed that Central American sources can generally be distinguished from one another using only a handful of elemental concentrations collected during short-irradiation INAA (Glascock *et al.* 1998), for instance Mn and Dy, elements which were found to measure comparability at both the EAF (LA-ICP-MS) and MURR. Figure 3 shows the single samples comprising groups 3 (SJB026) and 4 (SJB025) projected against the 2-sigma ranges for Mn and Dy concentrations for Central Mexican obsidian sources. Group 3 is a close match for the Ucareo source in Michoacan, while group 4 overlaps with the chemical range of the Zacualtipan source in Hidalgo.

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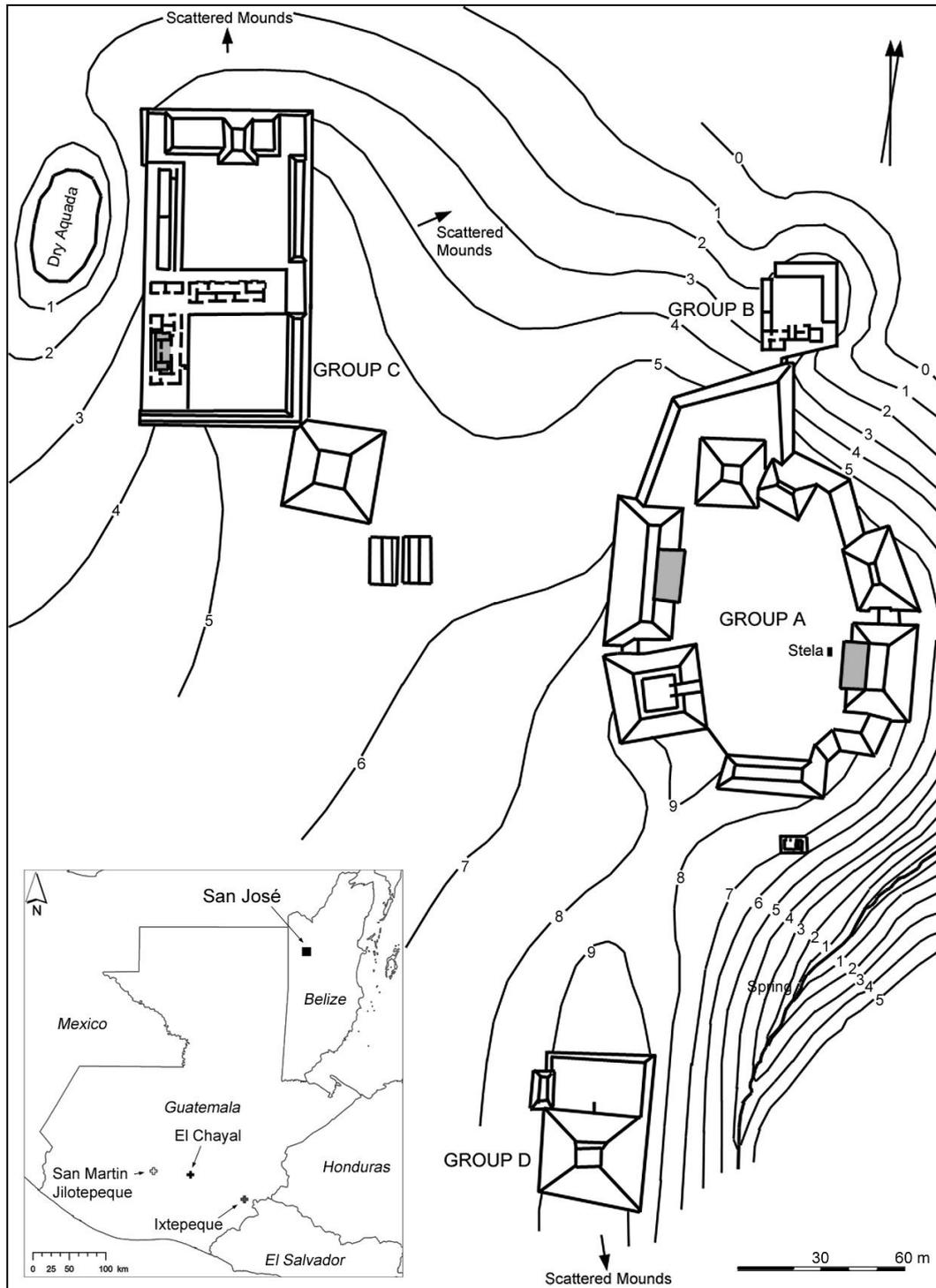


Figure 1. Map of San José, Belize (redrawn from Thompson 1939: fig. 1).

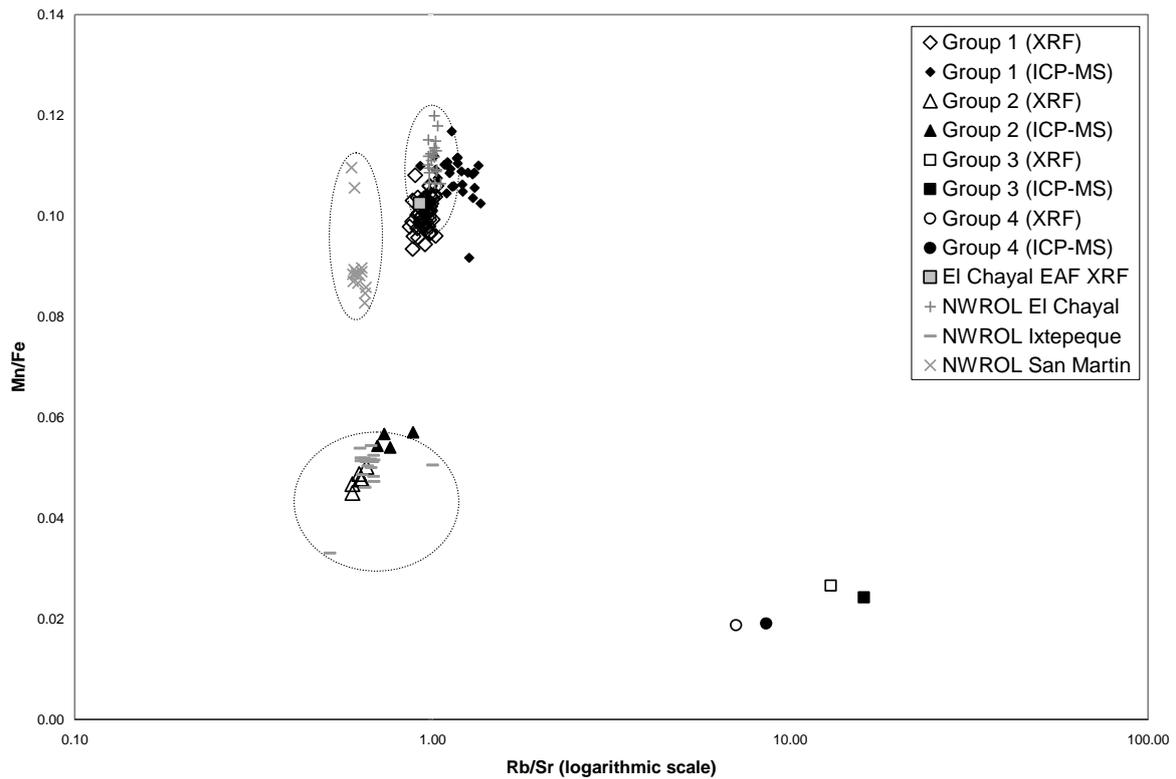


Figure 2. Bivariate plot of Rb/Sr and Mn/Fe ratios in specimens measured by LA-ICP-MS, plotted against values for the three major Guatemalan obsidian sources. Ellipses delimit the approximate limits of variability published for the three major Guatemalan obsidian sources, and have no statistical significance.

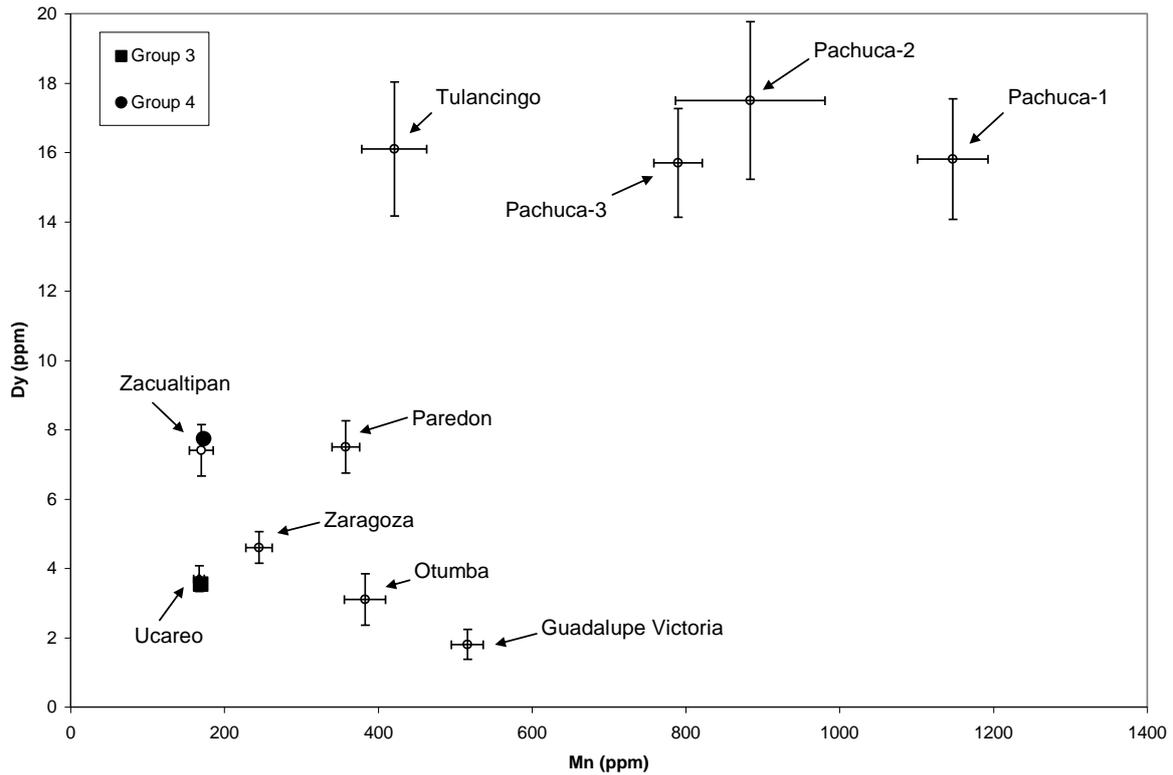


Figure 3. LA-ICP-MS measurements of Mn and Dy concentrations for Groups 3 and 4 plotted against 2-sigma ranges for major Central Mexican obsidian sources as measured by INAA at Missouri University Research Reactor.