PHILIPPINE OBSIDIAN AND ITS ARCHAEOLOGICAL APPLICATIONS

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ABSTRACT

Obsidian sourcing has been used in Philippine archaeology for the first time. This paper discusses the potential of this new approach for studying the mobility patterns and exchange networks of early Filipinos. Currently, two obsidian sources have been identified in the Philippines. The Nagcarlan and Pagudpod sources are both located on the island of Luzon. X-ray fluorescence spectroscopy (XRF) was used to obtain a chemical signature of these sources and to link obsidian artefacts recovered at three archaeological sites to their geological source. The results provide evidence for long distance movement of obsidian in the past. A review of all known obsidian artefacts recovered from archaeological sites in the different islands and provinces of the Philippines provides essential background for further studies of obsidian movement and exchange.

INTRODUCTION

Obsidian is a natural volcanic glass formed by the rapid cooling of magma. Since it is very rich in silica, is homogeneous, and has excellent conchoidal fracturing properties, obsidian is an ideal raw material for flaked stone tools and various types of ornaments. In addition, obsidian from each geological setting has a relatively distinct chemical 'signature' which means that obsidian artefacts can be matched with their original geological source. The potential to obtain accurate characterization means that obsidian sourcing can play a significant role in understanding ancient activities, such as the movements and exchange networks of early people.

Geochemical characterization has been widely applied in the Mediterranean region, where the production and distribution of obsidian from a range of geological sources has been well studied (e.g. Dixon *et al.* 1972:80-8; Cann *et al.* 1969:578-91; Ammerman and Polglase 1993:101-7). Significant studies have also been conducted in the Indo-Pacific region (e.g. Ambrose and Green 1972:31; Bird *et al*. 1981; Duerden *et al*. 1987:232-38; Bellwood 1989:122-62; Anderson 1998:117-23; Spriggs 1991; Summerhayes 2000: 167-74; Chia 2001:146; Torrence 2004:115-25), in Korea and Japan (e.g. Sohn 1990:88-116; Motohashi 1996:131-37), in Russia (e.g. Kuzmin *et al.* 2002a, 2002b), in the Americas (e.g. Glascock *et al.* 1991:395-404; Johnson 1996:159-79), and also recently in the Philippines (Neri 2003:1-157; 2005:55-67; 2006:35-7). This paper will discuss the present status of obsidian studies in the Philippines and the potential for future archaeological research.

OBSIDIAN ARTEFACTS IN THE PHILIPPINES

Compared with other raw materials such as chert and andesite, obsidian is a scarce raw material at Philippine archaeological sites. It is worth summarizing the known distribution of obsidian on archaeological sites to show the potential for long distance movement and exchange. Beyer (1947:205-392) made a compilation of archaeological finds and sites from the different islands in the Philippines and recorded obsidian artefacts in the Luzon area only. During his archaeological explorations from 1926-1941, Beyer found obsidian in Rizal, Cavite, Batangas and Bulacan Provinces (Figure 1). Other samples presented to him were collected by his colleagues from Ilocos Norte and Laguna Provinces.

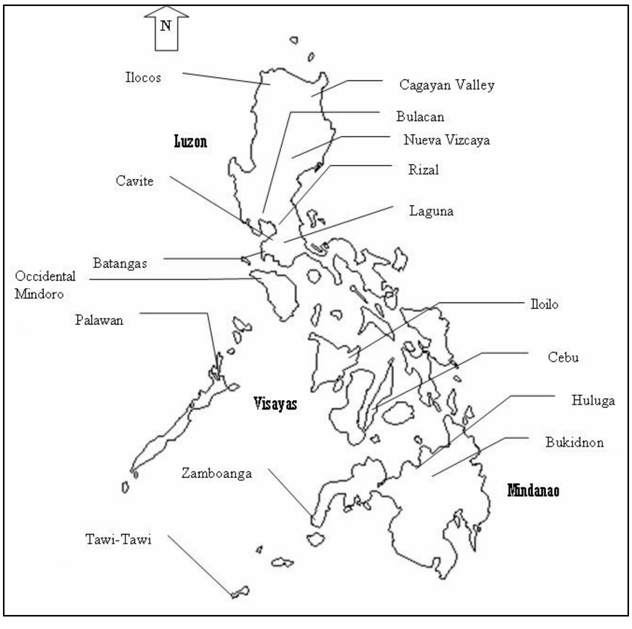

Figure 1. Map of the Philippines showing provinces where obsidian artefacts have been found.

In Rizal Province, Beyer (1947:230) obtained obsidian from areas which he divided into different districts. In the Novaliches-Marilao District and the Lake District, he recovered obsidian and flint microliths, which he dated to the Mesolithic Era. In the province of Cavite, Beyer (1947:242) collected obsidian and flint microliths from plowed areas, particularly along the main road to Tagaytay and the nearby Indang region. In the province of Bulacan, particularly in the Pugad-Baboy and Maysan areas, he found a concentration of natural tektites associated with Mesolithic obsidian and flint microliths.

The province of Batangas was considered by Beyer (1947:243)

> to be the most important archaeological area yet discovered in the Philippines, and, as regards its uniquely rich Late Neolithic remains, one of the most remarkable Late Stone-Age sites found anywhere in the world.

In 1934, Beyer made an exploration in Lipa, particularly in Balite Barrio, where he recovered 25 flaked obsidian implements. The Central District and Special Sites were divided by Beyer into the San Juan River Valley, Pasig-Tagig, Marikina-Puray, Special Santa Ana Site and Special Manila Site. San Juan River Valley and Pasig-Tagig subdistricts yielded obsidian materials associated with 'flint' flakes, stone adzes, chisels and tektites which Beyer (1947:238) believed also belonged to the Late Neolithic Period.

In Lemery, Batangas Province, an extensive archaeological excavation has been conducted by the Ateneo de Manila University (Paterno 1981). A number of amorphous obsidian artefacts were recovered *in situ*. These were associated with earthenware sherds, animal bones, and other lithic materials. Based on the results of thermoluminescence dating, it was inferred that obsidian was already used between 1800 and 1450 BC, or between what Beyer called the Late Palaeolithic and Early Neolithic Periods. These specimens from Lemery are important because they are the first dated obsidian artefacts recovered in good context in the Philippines.

Not far from Lemery, Ronquillo and Ogawa (1996:133-43) undertook archaeological explorations and conducted systematic excavations in the municipalities of Calatagan and Lian in Batangas Province (Figure 1). Two of their sites yielded obsidian materials: De los Reyes Property I and II. These sites are located in Sitio Dayap, Tanagan Village, southeast from the town of Calatagan. Vesicular basalt and andesite were recovered in De los Reyes Property I, along with obsidian flakes, earthenware sherds, four types of beads, net weights, animal remains and lithic materials including quartz. Artefacts, ecofacts and archaeological features provided information that the area was utilized for habitation. According to Ronquillo and Ogawa (1996:141):

> This is deemed significant since all sites worked and reported on at Calatagan were burial areas and no actual habitation sites have been documented to date.

At the De los Reyes Property II, located 800 meters southeast of the De los Reyes Property I, archaeological materials recovered from the excavations included obsidian flakes, earthenware sherds, celadon sherds, blue/white porcelain sherds, seeds, bone and shell fragments, broken pieces of metal and animal teeth.

Excavations at Ulilang Bundoc, Sitio Dayap, Tanagan Village, Calatagan, Batangas Province, yielded obsidian flakes (de la Torre 1997, 2002; Bautista 1995). Ulilang Bundoc is a knoll, approximately 32 meters above sea level. Some of the obsidian flakes that were recovered were associated with secondary earthenware burial jars. Also recovered from the jars, aside from the disarticulated skeletal remains, were beads, polished stone adzes and shells of edible shellfish. The burial jars have been dated to the Late Metal Age Period (500 BC-AD 850). This research is very significant in the history of the Philippines, since this is the first time obsidian has been associated with a burial context.

Obsidian has been reported from Pintu shelter in Nueva Vizcaya fairly near the central east coast. Peterson (1974:28) stated that cryptocrystallines such as flint, chert, chalcedony and obsidian were also represented in small amounts. He did not report whether the obsidian was from Neolithic or underlying pre-Neolithic levels. This is the furthest north obsidian has been reported in Luzon, apart from the Ilocos Norte finds reported below and recent finds from Cagayan Province, which is also in the extreme north. The Cagayan finds come from the site of Santa Maria, where two obsidian flakes were noted in a silty clay layer associated with red-slipped Neolithic pottery (Ogawa 1998:147-8; cf. de la Torre 2000:82 who mentions only one obsidian flake). Ilocos Norte and Laguna have yielded obsidian materials, but were not personally explored by Beyer (Figure 1). Obsidian microliths were sent to Beyer by a local geologist who claimed they had been found near Pasuquin, Ilocos Norte. Beyer (1947:215) suggested that 'the area should be further explored, as no other obsidian implement has yet been reliably reported north of Bulakan Province'.

In 1945, a Dutch archaeologist, H.R. Van Heekeren, found 25 to 30 pieces of obsidian flakes and flint semi-microliths in the foothills of Mt. Makiling, Laguna Province. In Pila and at Talim Island in the same province, obsidian flakes were also found *in situ* (Fernandez and Rogel 1968:7-12). The researchers believed that these obsidians dated from the Pleistocene. Unfortunately, the report has no details about the stratigraphy and recovery of the obsidian artefacts. Scott (1968:23) also reported obsidian microliths from Bulacan Province down to the Bicol region to the southeast. Scott (1968:23) and Fox (1959:13) wrote that the only possible source of obsidian is located at Mount Banahaw, Central Luzon. Scott (1968:23) also claimed that 'this wide distribution bespeaks a considerable commercial mobility among Mesolithic Filipinos.' This paper reports new geochemical work designed to test Scott's hypothesis.

Obsidian flakes were also recovered in the rockshelter of the Ille limestone tower in the valley of Dewil, New Ibajay, in the municipality of El Nido, Palawan Province

(Paz and Ronquillo 2004). This excavation is part of the palaeohistoric research project conducted by the Archaeological Studies Program (ASP), University of the Philippines, and the National Museum of the Philippines. These obsidian flakes were recovered between 180-190 cm below the surface of the 'East Mouth excavation' and were associated with other lithic flake materials. These obsidian flakes are believed to date older than 10,000 BP, within the Palaeolithic Period.

In 1996 Mijares (1996:34) reported finding weathered obsidian flakes on the surface of Tinokod Cave in the Luyang Baga Cave Complex in Mindoro Occidental Province, Mindoro Island. The flakes have lengths of 1.2 to 2.7 cm and widths of 0.5 to 2.0 cm. This site is believed to be a habitation and/or ritual site which may date to the Neolithic Period.

In 1978, Tenazas (1985) found obsidian at two sites in the municipality of Carcar, Cebu Province, 50 km south of Cebu City (Figure 1). Tenazas collected obsidian flakes associated with quartz flakes on the surface of the Tagotong Hill Site, some of which are on display at the San Carlos Museum, San Carlos University, Cebu City. She (1985:208) attributed them to the late Pleistocene or early Holocene, describing them elsewhere as 'an industry of small obsidian flakes.' To date, this is the first recorded occurrence in the Visayas of obsidian artefacts from an archaeological site. Recently, five amorphous obsidian flakes associated with other flake tools, earthenwares sherds, animal bones and marine shells were recovered from the municipality of Alegria in the same province (Tiauzon, pers. comm.,c 2006). From the municipality of Tigbauan, province of Iloilo on Panay Island in the western Visayas (Figure 1), Beyer (1947:294) had earlier reported 'one much worn obsidian implement' of unknown age. Unfortunately, this was stored at the Bureau of Science and destroyed during World War II.

Seven obsidian flakes were recovered both outside and inside the Bungiao Rockshelter, located in the village of Bungiao, Manicahan Municipality, Zamboanga Province (Coutts and Wesson 1980:256; Spoehr 1973:259) (Figure 1). These obsidian flakes vary from circular (14-18 mm in diameter and from 1-4 mm thick) to irregular shapes (19-29 mm long and 2-8 mm thick). The obsidian flakes collected were unretouched and possessed sharp edges for scraping and cutting purposes. Spoehr (1973:77) believed that the rock shelter 'was first used at a time somewhere prior to the introduction of trade ceramics, though how much earlier cannot be determined.' In Tawi-Tawi Province, southwest from Zamboanga, an obsidian flake was found in Balobok Rockshelter on the island of Sanga Sanga (Coutts and Wesson 1980:256; Spoehr 1973:259) (Figure 1). The flake measures 20 mm in length and 1 mm in thickness and lacks retouch. Further exavations by the National Museum did not reveal any additional obsidian flakes. This site is very close to the coast of Sabah.

Archaeological and ethnographic assessments during 1995 in Bukidnon Province, Mindanao, by the South East Asian Institute of Culture and Environment (SEA-ICE), in compliance with the requirements for the Environmental Impact Studies agreements for the proposed Pulangi V Hydroelectric Project (SEA-ICE 1995), systematically explored and excavated 11 sites, but only two sites in the villages of Sanipon and Bukang Liwayway yielded obsidian artefacts. During archaeological survey in Sanipon, Kibawe Municipality, in the floodplain area of Pulangi River (SEA-ICE 1995), obsidian flakes, chert flakes, Chinese tradeware ceramics, earthenware sherds and recent materials such as rusted nails and other metal objects were found. At Bukang Liwayway, on the left bank of the Pulangi River, surface finds included obsidian flakes, chert flakes, sherds of ceramic tradeware and rusted metal objects. Unfortunately, the obsidian artefacts were only recovered from the ground surface.

The most recent recovery of obsidian materials in Mindanao is from the Huluga open site, Cagayan de Oro City (Neri 2003:1-157; Neri *et al.* 2004:1-71). Here, a number of obsidian artefacts were recovered and, for the first time in the history of Philippine archaeology, their geochemical and morphological attributes have been analyzed.

In summary, prehistoric obsidian artefacts from the Philippines mostly comprise of flakes and debitage, the majority of which are amorphous. Some have been recovered from securely dated contexts while others are derived from unknown provenances. Based on a review of the literature, obsidian was utilized in the Philippine Islands during the Palaeolithic Period prior to 10,000 years ago, and continued in use until the Late Metal Age. Given the widespread and long term use of obsidian in the Philippines, there is considerable potential for using geochemical characterization studies to study patterns of mobility and exchange.

OBSIDIAN SOURCES IN THE PHILIPPINES

The first stage in conducting characterization studies of obsidian is to locate the possible geological sources that could have been used in the past (e.g. Shackley 2005; Tykot 2003; Torrence *et al.* 1992). Obsidian sources in the Philippines are surprisingly rare, despite the fact that most of the islands are volcanic in origin, with more than 200 volcanoes, of which 22 are considered active (PHIVOLCS 1997:1-78). According to the Bureau of Mines (2000:2) 'obsidian is associated with quaternary volcanics in Mabitac, Laguna and in Pagudpod, Ilocos Norte.' At present, the only two obsidian sources known in the Philippines are the Pagudpod source and the Nagcarlan source. They are located respectively in the village of Caunayan, Municipality of Pagudpod, Ilocos Norte Province (18° 37' 35" N, 120° 49' 51" E), and the village of Manaol, Municipality of Nagcarlan, Laguna (14° 10' 41" N, 121° 21' 52" E) (Neri 2003:33-35) (Figure 2).

The Pagudpod source is a highly weathered conglomeratic deposit consisting of rounded cobble and pebble sized grains from 3-10 cm in diameter, set in a medium to coarse grain matrix (Figure 3). The deposit has crudely developed bedding and was probably deposited by colluvial and/or alluvial action. According to the local informant, when wet, especially after rain, the obsidian turns

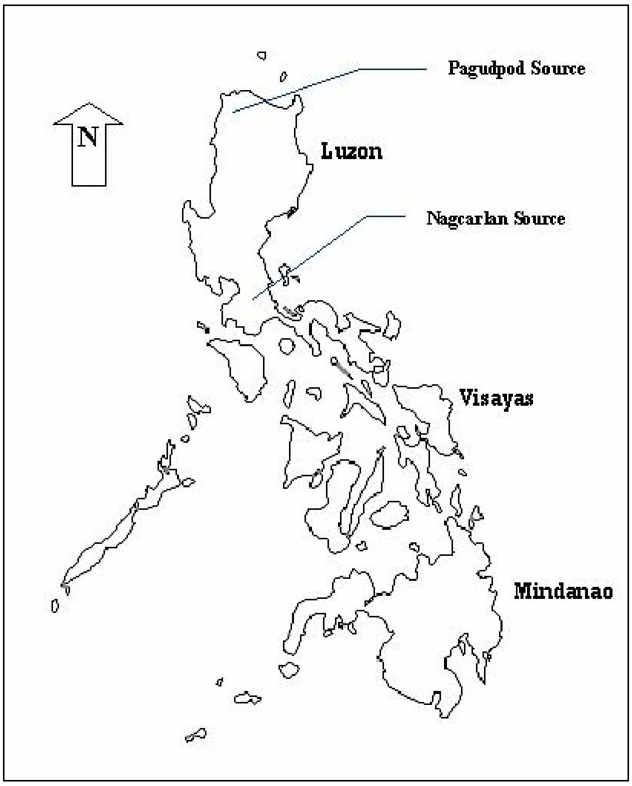

Figure 2. Map of the Philippines showing the two known sources of obsidian.

green, which is why the local term for this glass is 'Berdadero,' meaning a high-class type of green stone. The source is found in the Caunayan forest. According to Mr. Artemio Lurenzo, Chief Village Patrol, this glassy material was being quarried by the locals and sold at Php 20/kilo to some people from Cagayan Valley in Northern Luzon, for unknown purposes.

The author was led to the second source in Nagcarlan by Mr. Larry Bisbe, Village Chairman in Manaol. The Nagcarlan source is a secondary deposit represented by cobble to boulder sized pieces which were exposed along the lower ridges of volcanic plugs (Figure 4). Obsidian was also scattered along the surfaces of the slopes of Mt. Tangob. The local term for obsidian is 'Batong Dalig,' which refers to the name of the place. The obsidian found in this area has high opacity. It is a dark colored glass containing elongated or rounded bubbles, as reported by the Bureau of Mines (2000:6).

The obsidian materials found in this area have the following characteristics. Fracture is conchoidal; lustre is vitreous. It is opaque to transparent and isotropic with a refractive index of 1.48 to 1.52. The hardness ranges from 5 to 5.5 on the Moh scale and the specific gravity varies from 2.33 to 2.50, depending on the abundance of vesicles. It consists mainly of glass with some minute inclusions of crystallites and amygdules of quartz and zeolites (Bureau of Mines 1968:309).

GEOCHEMICAL SOURCING

Four obsidian samples from the Nagcarlan source and two samples from the Pagudpod source collected by the author

Figure 3. Outcrop of obsidian at the Pagudpod source, Ilocos Norte.

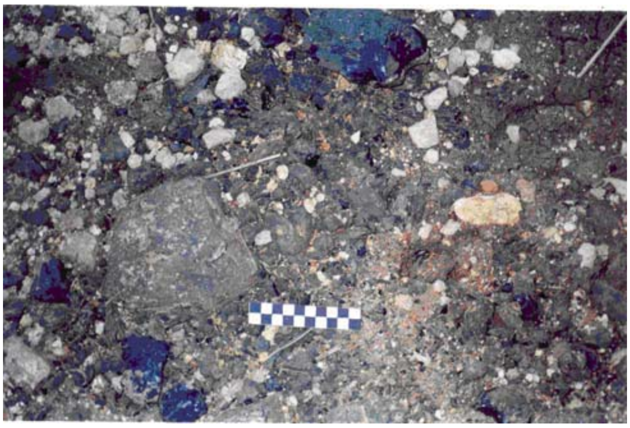

Figure 4. Outcrop of obsidian at the Nagcarlan source, Laguna

and analyzed using X-ray fluorescence spectroscopy (XRF) by Craig Skinner at the Northwest Research Obsidian Studies Laboratory in Corvallis, Oregon, USA. The results show that each of the two Philippines sources has a diagnostic chemical 'signature,' based on the trace elements Zr, Rb and Sr, as shown in Figures 5 and 6 (Neri 2003:70-80; 2006:35-37).

The next stage in a characterization study is to compare the geochemical compositions of artefacts with those of known outcrops so that the artefacts can be traced back to their sources. The direction and distance that the artefacts have moved provides an indication of either mobility of people and/or exchange. Obsidians recovered from Ulilang Bundoc, Huluga and Ille Rockshelter were geochemically analyzed using X-ray fluorescence spectroscopy (Table 1). These archaeological sites were chosen because of the good archaeological provenance and avail ability of artefacts for chemical sampling (Figure 7).

Seven obsidian samples from Ulilang Bundoc site were analysed (Table 1). The chemical concentrations of eleven trace elements were then compared to the known obsidian sources in the island of Luzon. Based on results shown in the binary and ternary diagrams in Figures 8 and 9, artifacts from the Ulilang Bundoc Site were matched to the obsidian source of Nagcarlan. This result provides fresh insights into exchange patterns in the past because

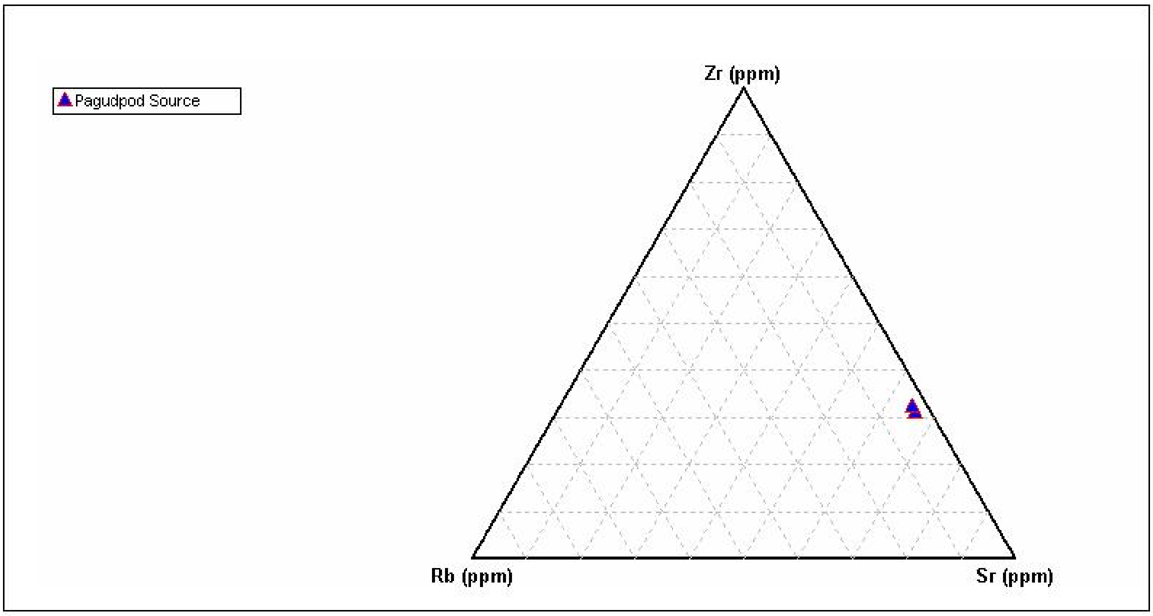

Figure 5. Ternary diagram for the Pagudpod source.

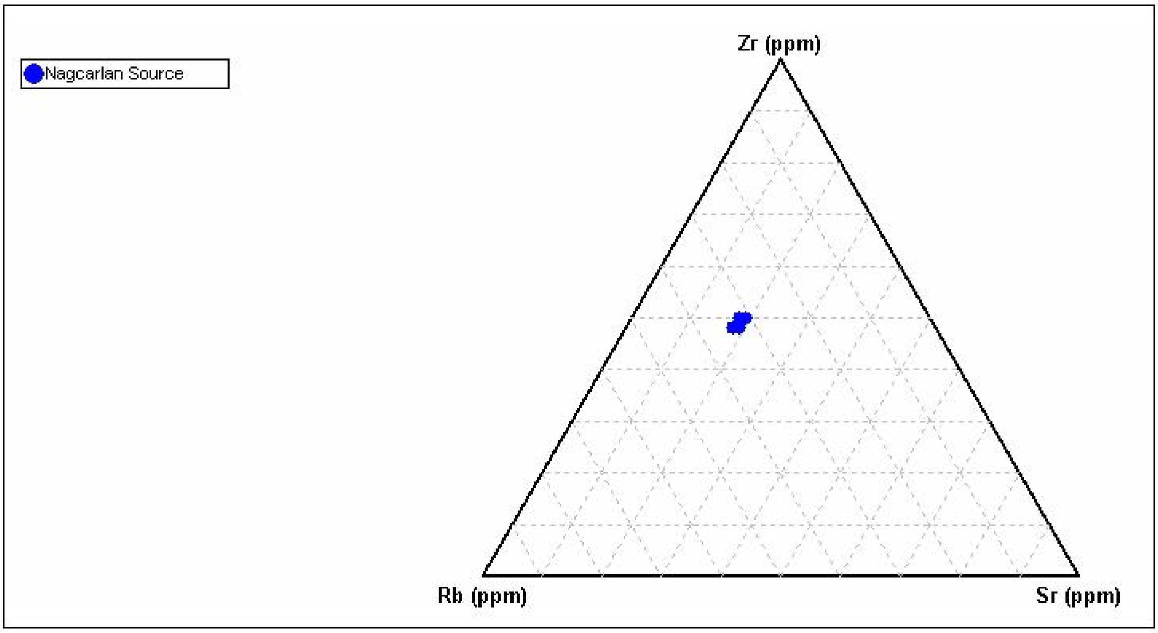

Figure 6. Ternary diagram for the Nagcarlan source.

the source is located approximately 60-70 km northeast of the Ulilang Bundoc site (Neri *et al.* in preparation).

Another archaeological site whose obsidian samples were subjected to chemical analysis is the Huluga Open Site in Cagayan de Oro on the northern coast of Mindanao (Figure 7). Thirty-five obsidian samples were chemically analyzed using X-ray fluorescence spectroscopy (Table 1). Obsidian from Huluga has a unique chemical range that does not match any of the known obsidian source samples analysed (Figures 8, 9). Based on the binary diagram (Figure 9), the trace element compositions from the Huluga Open Site have a unique 'fingerprint' and may not be derived from the known obsidian sources in Luzon.

Since no two volcanoes will have exactly the same geochemical elemental values (Mason 1966), what Butzer (1993) called a 'fingerprint,' one can compare the compositions of the obsidians with other volcanoes in the region to see if there may be other undiscovered sources of obsidian. Rogers and Hawkesworth (2000:123) have noted that

> trace elements are widely used in the study of volcanic rocks to understand the processes that produce igne-

ous rocks, because they are very much more sensitive to the amount of melting, and the elemental abundances in the original source.

The trace chemical compositions of the obsidian recovered from Huluga were compared to the geochemistry, geochronology and magmatism of the volcanoes in Mindanao (Neri 2003), based on data presented in Sajona *et al.* (1997, 2000). Within the different volcanoes in Mindanao, strontium (Sr) ranges from 307-1070 ppm, but the Huluga obsidian values fall between 0-10 ppm. The elemental values of rubidium (Rb) in Mindanao range from 9-99 ppm, compared with 234-316 ppm for the Huluga artefacts. In other words, the Mindanao 'signature' is high in strontium (Sr) and low in rubidium (Rb) compared to the chemical components in the Huluga obsidian, which has low strontium (Sr) values but is high in rubidium (Rb). The difference was confirmed by Sajona (pers. comm., 2003) who stated that the trace elements present in the Huluga obsidian samples could not have been produced in Mindanao.

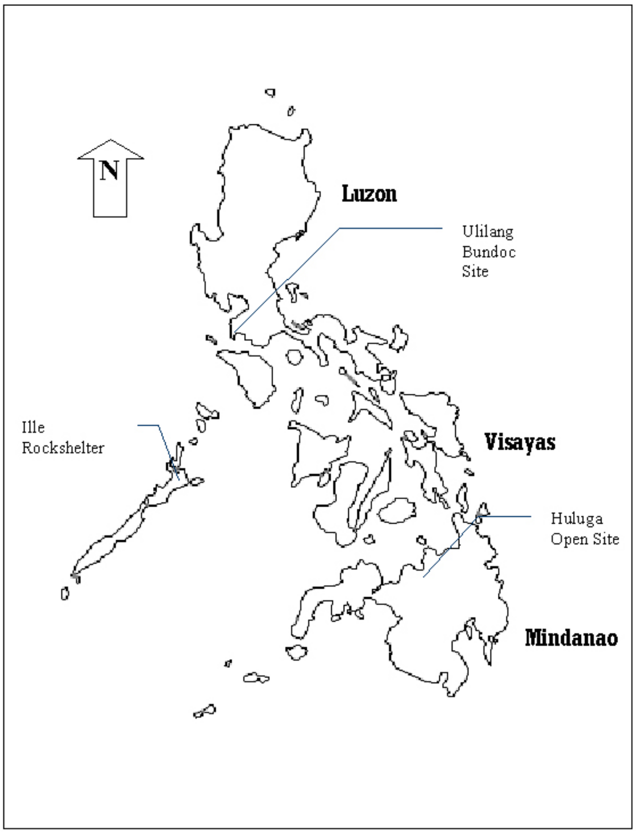

Figure 7. Map of the Philippines showing location of sites for obsidian artefacts analysed by XRF.

It is thus most likely that the Huluga obsidian originated from somewhere outside the island of Mindanao. Currently, according to the Bureau of Mines (2000), the Visayas are devoid of obsidian outcrops. This further suggests that the obsidian from Huluga might have been acquired through exchange from outside the Philippines.

Of the four obsidian artefacts from the Ille Rockshelter, only one was identified as obsidian (Neri 2006), and it was then analyzed using XRF (Table 1). It is high in zirconium (Zr) and very low in lead (Pb). Based on the ternary and binary diagrams of the known obsidian sources, the trace element composition of this Ille artefact does not match the known obsidian sources in Luzon (Figures 8 and 9). Although a single sample cannot represent the range of variability of a single source, this artefact is so different that it must be derived from a different source.

Table 1. Results of geochemical characterization of artefacts from Philippine archaeological sites.

Site	Number of samples analyzed	Technique	Provenance
Ulilang Bundoc Site	7	XRF	Nagcarlan Source
Huluga Open Site	35	XRF	Unknown
Ille Rockshelter	1	XRF	Unknown

DISCUSSION

To date, the only known obsidian sources in the Philippines are the Nagcarlan and Pagudpod outcrops, both located on the island of Luzon. Each has a very distinctive geochemical 'signature.' Artefacts from the Ulilang Bundoc Site, Huluga and Ille Rockshelter were analysed using XRF. Surprisingly, the artefacts from the majority of the sites studied were not derived from the two known obsidian sources in Luzon. The exception is Ulilang Bundoc, which has obsidian from the local Nagcarlan source, but not from the Pagudpod source. This result provides fresh insight into exchange patterns because the source is located approximately 60-70 km northeast of the site. The results also suggest that obsidian had a significant value to the people since artefacts were recovered from secondary burial jars.

Although the source of the obsidian is currently unknown, the trace element values for artefacts from the Huluga Open Site suggest they were derived from a single source located outside the Philippines. Unfortunately, the time depth of the Huluga obsidian artefacts is unknown because they were recovered from ploughed farmland.

The source of the single piece from Ille Rockshelter is also likely to have been located outside the Philippine islands, but was different from the Huluga source. This piece of obsidian is very important because it was recovered in a primary context dated to the Late Palaeolithic. Although a tentative speculation since we only have a single sample, it seems possible that people were already engaged in exchange with groups from neighbouring regions at that early date. Since Palawan is non-volcanic, any obsidian recovered from sites there provides significant archaeological evidence for exchange.

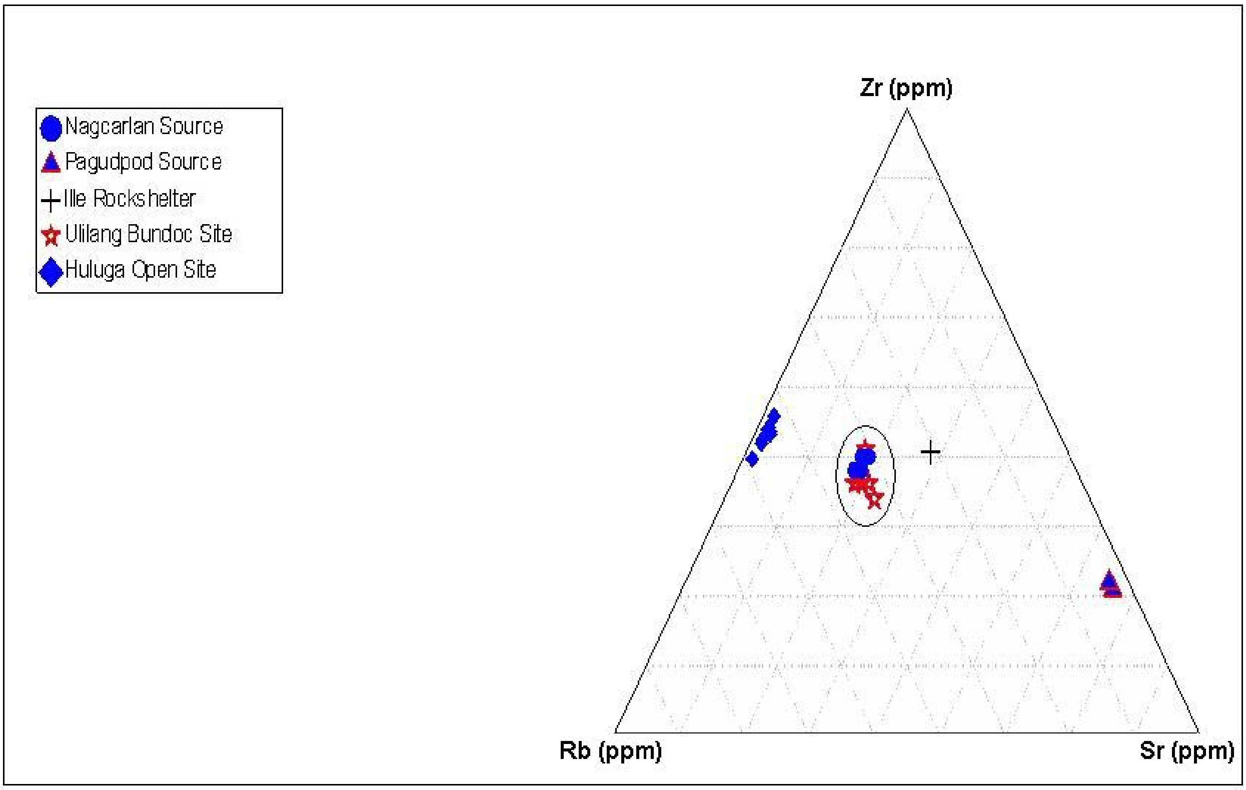

Figure 8. Ternary diagram showing XRF results from sources and archaeological artefacts.

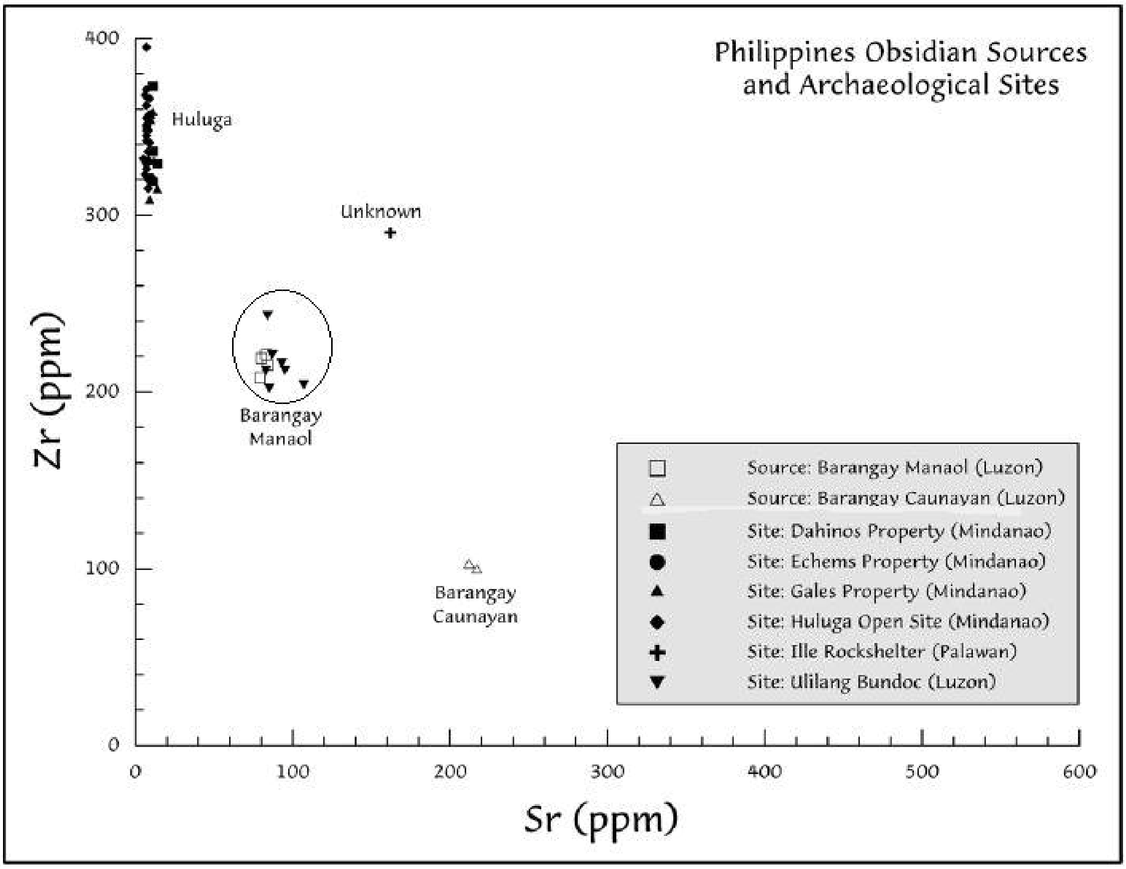

Figure 9. Binary diagram showing the XRF results from sources and archaeological artefacts.

Until the unknown sources represented at Huluga and Ille have been definitely identified, the results can only suggest the possibility for exchange with communities outside the Philippine islands. But at this early stage of research on obsidian characterization, these are still very significant results.

CONCLUSIONS

Geochemical characterization of obsidian can make an important contribution by providing information about the movements of people in the past. The study of obsidian sourcing in the Philippines also has great potential for understanding how early Filipinos interacted regionally within Southeast Asia. This preliminary research has demonstrated the potential of this type of investigation but additional study is necessary to definitively locate the obsidian sources identified in the geochemical analyses. A range of future research strategies are planned:

a. conduct a thorough geological survey of all possible obsidian sources in the Philippines, specifically in the Mindanao area, and make a comparative database of their geochemical compositions;
b. further improve the geochemical trace element database for the different volcanoes in Mindanao as a possible basis for geochemical sourcing;
c. expand the geographic scope of obsidian sourcing in Southeast Asia and other neighboring islands.

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