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Multitemporal analysis for preservation of obsidian sources from Melka Kunture (Ethiopia): integration of fieldwork activities, digital aerial photogrammetry and multispectral stereo-IKONOS II analysis

Maria Cristina Salvi*, Riccardo Salvini, Alice Cartocci, Simone Kozciak, Rosalia Gallotti, Marcello Piperno

University of Siena, Centre for GeoTechnologies, Via Vetri Vecchi, 34, 52027, San Giovanni Valdarno, Arezzo, Italy

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ABSTRACT

An integrated analysis of recent satellite imageries and dated aerial photos demonstrated to be a good investigation tool (Gallo et al., 2009) for the identification of new sites and for the assessment of landscape changes of wide archaeological areas in Ethiopia.

In the Melka Kunture archaeological sequence, the obsidian exploitation represents a leitmotiv during the last 1.7 Myr and the first known example of Oldowan utilization (Piperno et al., 2009).

The primary nearest obsidian source, the site of Balchit, 7 km North from Melka Kunture, is a dome-flow dated to 4.37 ± 0.07 Myr (Chernet et al., 1998). Large areas of the Balchit site are covered by secondary obsidian debris resulting from the erosion of primary sources.

The proximity between primary and secondary Balchit obsidian sources and the high quality of this raw material, easily available in large quantity, represent a unique condition in the framework of the Oldowan and Acheulian East African sites (Piperno et al., 2009).

In order to evaluate the human impact on the multitemporal change of obsidian sources, the land use of the study area, following the CORINE Land Cover Nomenclature, has been classified from aerial photos and IKONOS II imageries, respectively dated to 1972 and 2006. The accurate positioning of the primary and secondary sources and their extent have been measured thanks to the multispectral characteristics and to the high spatial resolution of the available imageries.

Satellite scenes, covering an area of about 100 km^2, have been also utilized in stereoscopy for the creation of the new topographic map, at the scale of 1:10,000, and of the Digital Elevation Model (DEM).

Images orientation has been performed through the use of Rational Polynomial Coefficients (RPC) which accuracy has been improved by the availability of Ground Control Points (GCPs) properly measured during a DGPS survey. Then, the images have been orthorectified and radiometrically and spectrally enhanced in order to favour the recognition of obsidian presence, in respect with ground observations collected during fieldworks.

Photointerpretation and semi-automatic classification processes of images have been performed with the support of spectral signatures of obsidian samples recorded by a FieldSpec Pro spectroradiometer, ranging in the visible-short wave infrared electromagnetic interval (0.4–2.5 μm).

1. The Balchit obsidian

The site of Balchit, located 7 km North of Melka Kunture (Fig. 1), is one of the most important palaeolithic sites of the African world (Piperno et al., 2009; Poupeau et al., 2004) with an extent greater than 300 ha. Due to the extension of the site (over 100 km^2), the cultural palaeolithic sequence, dated from 1.7 to 0.2 Myr, and the variety of the archaeological remains of different chronological phases, Melka Kunture, located 50 km South of Addis Abeba in the Upper Awash River basin, represents a very important prehistoric site of high scientific value (Chavaillon and Piperno, 2004). More than 80 archaeological layers have been identified during 40 years of researches; 30 of them have been extensively excavated with surfaces ranging from 50 to 250 m^2. Several thousands of lithic tools, faunal and sometime human remains [*Homo erectus* (*sensu lato*) and archaic *Homo sapiens* (Coppens, 2004)] have been discovered for many archaeological layer.

* Corresponding author. Tel.: +39 329 7220678.
E-mail address: mcristinasalvi@gmail.com (M.C. Salvi).

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The area of Balchit is characterized by an obsidian primary source, dated to 4.37 ± 0.07 Myr (Chernet et al., 1998), and by the presence of obsidian debris with different size resulting from the erosion of the primary source. Obsidian cobbles and pebbles are also largely distributed in ancient, recent and present alluviums of the entire Melka Kunture region and available for prehistoric groups since Oldowan times.

Balchit obsidian geologically derives from a rhyolitic rock not crystallized while setting. The rock has a black colour with a very fine fluidity, even if some facies, affected by pneumatolithic actions or by oxidations, have a greenish or reddish colour. This natural glass, easy to break, is compact and homogeneous, hard and poorly porous, vitreous or with a fine texture (Poupeau et al., 2004). The Melka Kunture obsidian exploitation, during the Oldowan, represents the first known example of utilization of this high quality raw material. Its exploitation is more or less continuous in Melka Kunture area throughout the Acheulian; only two other Acheulian examples, Kariandusi and Kilombe (Gowlett, 1993; Gowlett and Crompton, 1994) are known in Eastern Africa and dated around 0.7 Myr. From the Middle Stone Age onwards, obsidian became the major component of the Melka Kunture lithic assemblages like in almost all the East African sites (Merrick et al., 1994; Piperno et al., 2009).

Concentration of obsidian debris and artifacts as large blades, flakes and pyramidal or prismatic cores at Balchit can be considered as the waste by-products of various “chaînes opératoires” aimed at different output and belonging to different ages, at least from the Late Stone Age to the modern times.

The primary obsidian source at Balchit included within volcanic sediments, is visible in several outcrops along gullies. Three types of concentrations of obsidian debris and artifacts are distinguishable: concentrations 60 m long and 50 cm thick, concentrations 10 m long and 1 m thick, and finally more limited modern pit-like depressions of anthropic origin, excavated to reach the ground water table and successively filled by obsidian wastes.

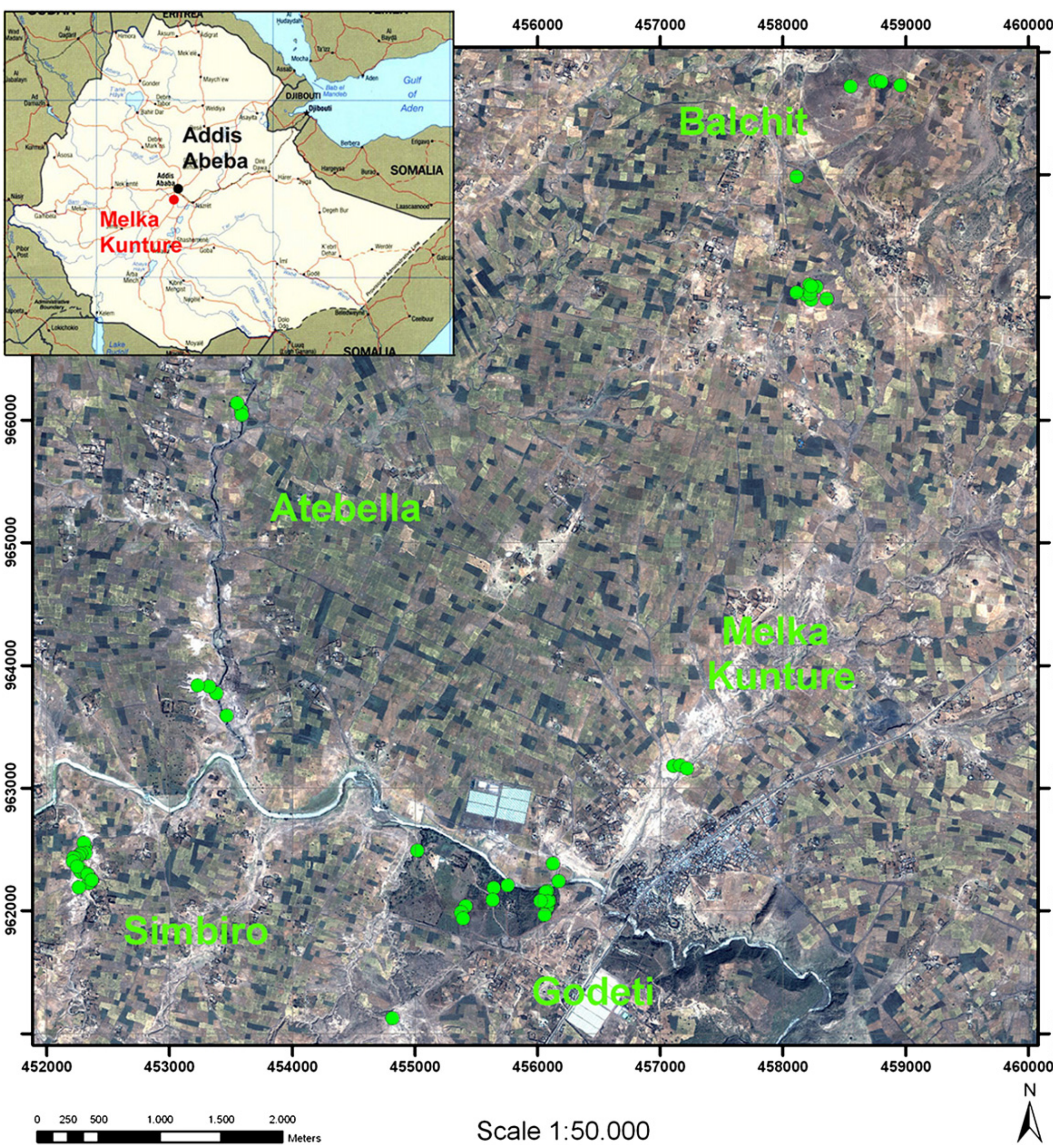

Fig. 1. Study area.