



A Geochemical and Mineralogical Approach for the Identification of Provenance of Stone Implements and Tempers in Ceramics from the Area of Mirabello in East Crete, Greece

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The Minoans of East Crete used a variety of rocks, usually in the form of water worn cobbles or pebbles, for use as ground stone implements. Generally, these were collected locally, not too distant from their settlement and hence easily accessible to them. The Minoans chose rock types that would be effective in domestic or industrial tasks which depended for the most part on the physical properties of the rocks. The most common rock types include sedimentary rocks such as limestones, sandstones, and breccias. However, an adequate amount of igneous and metamorphic rocks were employed as well for stone implements, such as basalt, dolerite, gabbro and various intermediate to acid plutonic rocks. Some of these were also used in crushed form as tempers in clay thus improving the properties of their ceramics. Pottery shards and ground stone implements form a large quantity of total assemblage of finds on recently excavated sites in East Crete ranging in date from Early Minoan to the Iron Age (ca. 3000-1000 B.C.), which revealed both domestic and/or extensive industrial activities. Moreover, the raw materials used for ground stone tools and ceramic temper deriving from the area of Mirabello Bay indicate the degree and range of the distribution of Mirabello products across the island over two millennia.

In this study we employed petrographic and mineralogical methods to investigate the composition of the raw materials encountered in the area, and we compare them to materials with similar lithologies from other parts of Crete in an attempt to discriminate between similar sources of raw materials used for lithics and pottery production across the island and not only within the area of Mirabello. More specifically, we investigated a series of intermediate to acid plutonic lithologies ranging in composition from diorite through quartz-diorite and granodiorite towards granite, as well as metamorphic rocks that include amphibolites and amphibolitic schists. Cretaceous, intermediate to acid plutonic rocks occur in several outcrops in the eastern and central parts of Crete. Amphibolites and amphibolite schists are sourced in three distinct nappes occurring in Crete: the Miamou Unit, which represents an ophiolite mélange, the Phyllite-Quartzite series that contains various low to medium grade metamorphic schists and phyllites and the Asteroussia Nappe which includes medium to high grade metamorphic rocks. Several rock-samples were collected for petrographic investigation and macroscopic comparison with the stone implements, as well as for mineralogical analysis. Numerous microanalyses were performed in certain key-minerals while X-ray diffractograms were also obtained from the intermediate to acid plutonic rocks.

Our results show significant chemical differences among the various lithologies. Especially amphiboles and feldspars can serve as excellent mineral indicators for provenance analysis. Through the use of various compositional plots we managed to differentiate the sources of the raw materials used for the manufacture of stone tools and those of the tempers used for pottery manufacture. We believe that we created a powerful tool in order to investigate the raw material provenance for ground stone tools and the presence and range of interaction of the various pottery workshops operating in the area of Mirabello in East Crete over a period of almost two millennia.