



Research paper

Characteristics of clay-rich raw materials for ceramic applications in Denizli region (Western Anatolia)



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ABSTRACT

This study focuses on the evaluation of the potential use of the clay-rich raw materials in Denizli region to manufacture traditional ceramic products with industrial processing and determination of the provenance of archaeological ceramics. For this context, physical, chemical (X-ray fluorescence, XRF), mineralogical (X-ray diffraction, XRD), and thermal analysis (Differential Thermal Analyser-Thermogravimetry, DTA-TG) were performed and plasticity indexes (PI) were determined on the five representative clay-rich materials from three different locations (Yenicekent, Başkarıcı and Pamukkale) in Denizli region. Samples have been prepared by pressing and firing in the range of 700–1200 °C, then bulk density (BD), water absorption (WA), and unconfined compression strength (UCS) values of the samples were determined. Highly plastic clays were mainly composed of illite, smectite, kaolinite and mixed-layered clay minerals. Quartz, calcite, dolomite and hematite were also detected as non-clay minerals. Chemical composition of the clay samples without carbonate minerals indicated that the main oxide compositions were SiO₂, Fe₂O₃ and Al₂O₃ whereas other oxides were present only in small quantities. Fired clays exhibited no major differences in BD and WA (except TR1). UCS values of all samples increased with rising firing temperatures. All technological properties showed significant densification at temperatures above 1000 °C. One of the studied clay-rich materials (TR3) has comparable characteristics for the production of structural ceramics as reference sample (KRC). Furthermore, this sample could be a potential raw material source for the archaeological ceramics in the region. In order to use TR2 sample it is necessary to add more plastic clays to enhance its workability, but other clays are not appropriate for such products.

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1. Introduction

Clays are very abundant at the earth's surface and generally consist of hydrous phyllo-silicates <0.002 mm in size. They have long been exploited for a very wide variety of industrial applications (ceramics, ink, purify oils, tires, pharmaceuticals, paper, paint, petroleum industry, etc.) (e.g., Guggenheim, 1997; Chang, 2002). One of the main industrial applications of the clays is production of ceramics, which are derived from common, naturally occurring raw materials such as clay and sands of quartz and/or feldspar minerals. The best-known products are pottery, glass, brick, tile, china porcelain, and cement.

Clayey raw materials for ceramic production have been extensively studied, particularly in the fields of industrial ceramic applications around the World (Baccour et al., 2008; Vieira et al., 2008; Meseguer et al., 2010; Celik, 2010; Diko et al., 2011; Ngun et al., 2011; Ngon Ngon et al., 2012; Lisboa et al., 2013; Dondi et al., 2014; El Ouahabi et al., 2014; Lahcen et al., 2014; Özkan, 2014; Boussem et al., 2016) and archaeological ceramics (Hein et al., 2002, 2004; Montana et al., 2011; Neyt et al., 2012). The ceramic industry in Turkey is one of the most important economic markets that has been rapidly growing since 1990 (Celik, 2010). In the Aegean region, extensive red firing clay deposits,

which are currently being used for traditional pottery and brick productions are widely seen (Afyon region, Celik, 2010; Turgutlu-Manisa region, Söylemez et al., 2011; Karacasu-Aydın region, Özkan, 2014; other Aegean clay, Özkan et al., 2010). The Denizli area also has a ceramic tradition. Başkarıcı and Sarayköy are two of the important centers of traditional production over a hundred years' background. This ceramic tradition however is decreasing day by day and a few examples are left that include the exploitation of local clays. Although clay-rich raw material is a primary material for local ceramic manufacturers, no study concerning with the quality and potential use of clay-rich materials from Denizli region was encountered. In this region, same situation is valid for clay materials used in the production of ancient pottery.

In Denizli region, two studies related to clay occurrences are previously performed. The first comprises the marine, continental and lacustrine clay deposits which are commonly used as a raw material in the cement production sector, which may be used together in different proportions (Özpinar et al., 2002). The second is related to the Serinhisar-Acıpayam basin, which is filled with fluvial and lacustrine sediments dominated by clayey materials (sepiolite, palygorskite, saponite and dolomitic sepiolite or palygorskite) (Akbulut and Kadir, 2003).

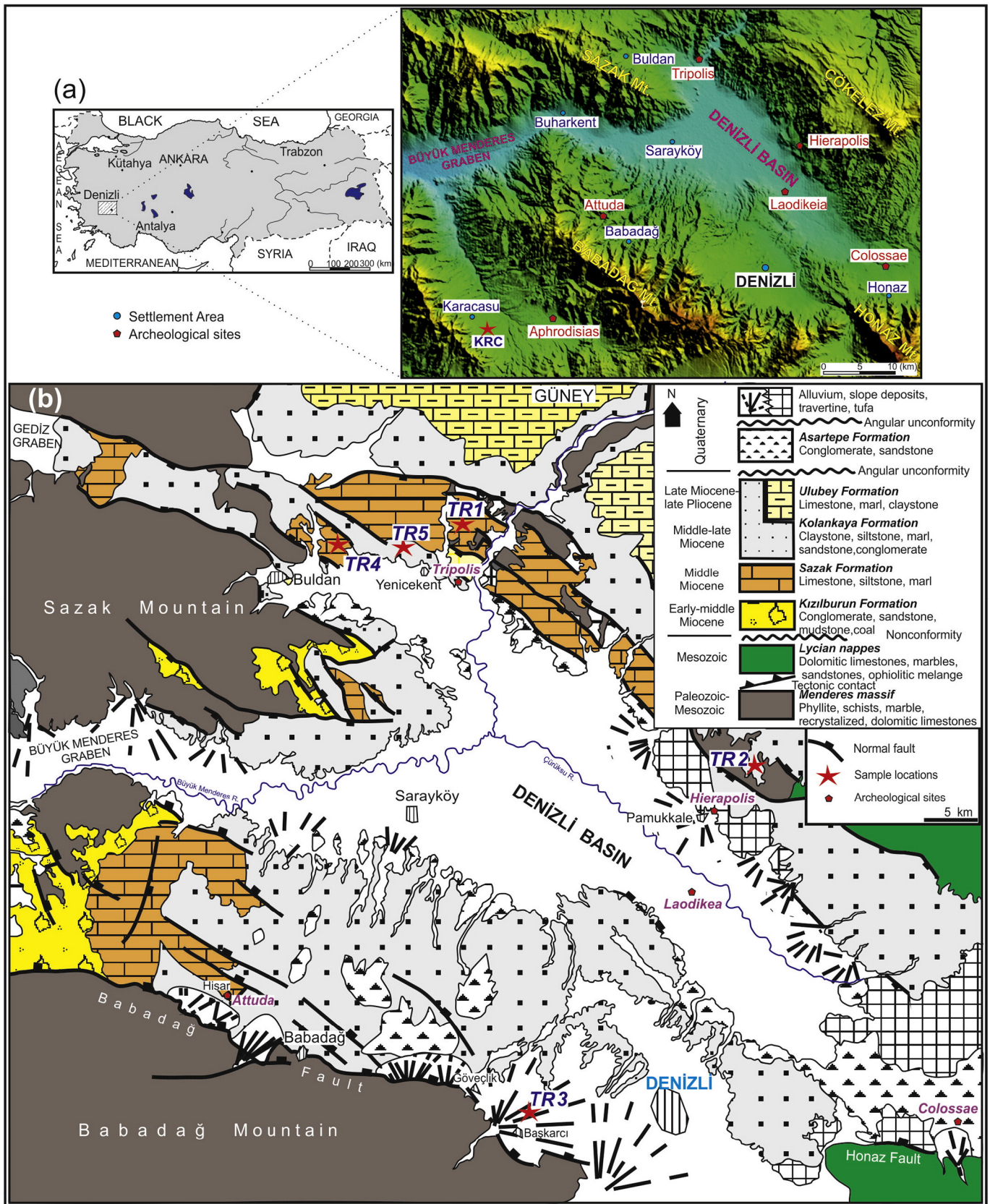


Fig. 1. a: Digital Elevation Model (DEM); b: Geological and location map of the study area. (For interpretation of the references to color in this figure, the reader is referred to the web version of this article.) (Modified by Alçiçek et al., 2007; Erten et al., 2014.)

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