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Research paper

Characterization of Iranian bentonites to be used as pharmaceutical materials

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ABSTRACT

Ten Iranian bentonites, sampled from the deposits of Chah-Golestan, Chah-Pirouz, Chah-Keshmir and Chah-Taleb (Sarayan), Gholeh-Gelia and Kharman-Sar (Ferdows, Khorasan), Mehrejan (Khoor) and Manian (Zagros) were analyzed to evaluate their potentialities as pharmaceutical products. The mineralogy, chemistry, pH, microbial content, powder flow characteristics, swelling capacity, cation exchange capacity, specific surface area, sedimentation volume, and rheological properties of all samples were determined. The bentonite located in carbonate rocks (Zagros) is made up of calcium montmorillonite (97%) and quartz (3%). The rest of the bentonites are hosted by Eocene volcanic rocks and are mainly made up of sodium montmorillonite (47%–84%) and cristobalite (up to 39%), with lesser quantities of quartz, calcite, plagioclase, zeolites and halite. Two of the samples (those located at Manian and Chah-Golestan C) showed appropriate composition, purity and technical properties to be used in pharmaceutical applications, whereas the rest would require purification or improvement of their properties. In particular, the samples could be used for topical dosage forms as rheological additives.

1. Introduction

Clay minerals are among the mostly used minerals in numerous applications. The most common uses are foundry sand bonds, drilling mud, ceramics, filtration, and iron ore pelletizing (Allo and Murray, 2004). Since early times various types of clay minerals have been used in the traditional medicines of most countries. The term "bentonite" is used in the industry for clays mostly composed of smectite group minerals (Grim and Guven, 1978). However in pharmaceutical literature, "bentonite" is used to refer to a natural, colloidal, hydrated aluminium silicate (Viseras et al., 2006; USP 36–NF 31, 2013). The main minerals of the smectite group are calcium montmorillonite, sodium montmorillonite, saponite, nontronite, hectorite, and beidelite (Murray, 2007). The colloidal size and structure of smectite minerals mean that they have a wide range of applications in industry as a result of their rheological properties, absorbing capacity, plasticity, high specific surface area, CEC and swelling properties. Among all members of clay minerals, calcium and sodium montmorillonites are among the most frequently used of all the clay minerals (Grim, 1962; Hartwell, 1965; Grim and Guven, 1978; Elzea and Murray, 1990; Harben and Bates, 1990; Konta, 1995; Luckham and Rossi, 1999; Allo and Murray, 2004; Eisenhour and Brown, 2009; Guven, 2009; Abdel-Motelib et al., 2011; Agha et al., 2012). Because of these various properties, bentonites are being used in an increasing number of applications, especially in the pharmaceutical industry (Williams et al., 2009; Abdel-Motelib et al., 2011; Carretero et al., 2013) and in pleotherapy and medical applications (Summa and Tateo, 1998; Cara et al., 2000; Veniale et al., 2004, 2007; Tateo and Summa, 2007; Carretero et al., 2010, 2014; Karakaya et al., 2010; Gomes et al., 2013).

The mineralogical and chemical compositions of bentonites depend on their evolution from parent rocks. Hence, their chemical composition and physical properties should be determined carefully before any usage, especially in cosmetic and pharmaceutical purposes, and special precautions should be taken (López-Galindo et al., 2007), given that a clay mineral must comply with several chemical, physical, and toxicological requirements for use in pharmaceutical formulations, depending on whether the purpose is therapeutic or cosmetic.

2. Geological setting

Iranian bentonite deposits occur in six zones (Semnan–Toroud, Alborz–Azerbaijan, Eastern Iran, Central Iran, Tafresh–Takab and Zagros), mostly in connection with Tertiary magmatism (Hejazi and Ghorbani, 1994).

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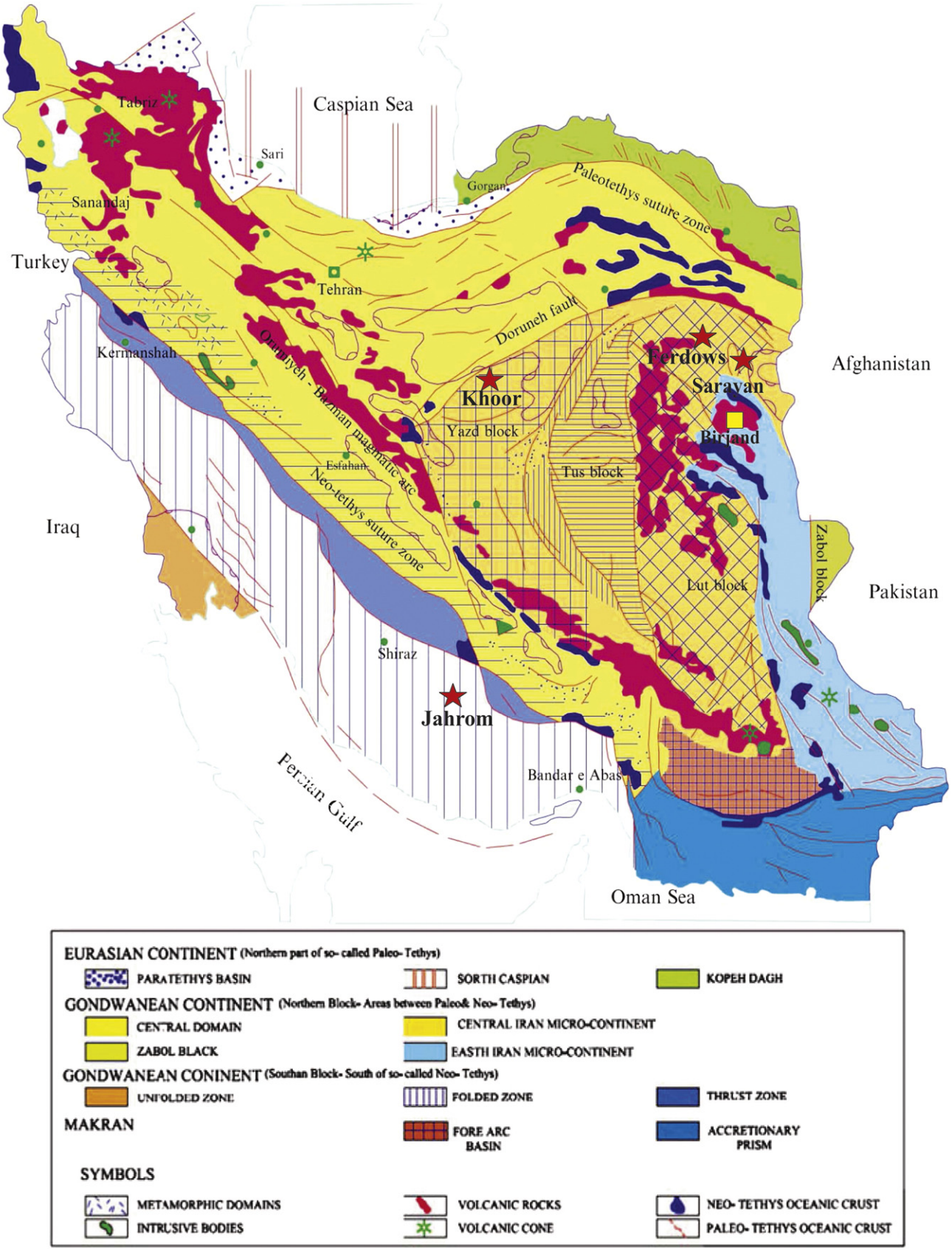

Fig. 1. Locations of the studied samples (red stars) on a geological map of Iran after Stocklin (1968) and Nabavi (1976).