Catena 121 (2014) 68–80

Contents lists available at ScienceDirect

Catena

journal homepage: www.elsevier.com/locate/catena

The dust provenance and transport mechanism for the Chengdu Clay in the Sichuan Basin, China

Jin-Liang Feng *, Zhao-Guo Hu, Jian-Ting Ju, Yong-Chong Lin

Key Laboratory of Tibetan Environment Changes and Land Surface Processes, Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing 100101, China

ARTICLE INFO

Article history:
Received 12 April 2013
Received in revised form 10 March 2014
Accepted 29 April 2014
Available online 27 May 2014

Keywords:
Loess
Chengdu Clay
Dust transport
Sichuan Basin
Tibetan Plateau
Chinese Loess Plateau

ABSTRACT

The Chengdu Clay in the Sichuan Basin, China, was named by Thorp and Dye in 1936. The genesis, dust provenance and transport mechanism for the Chengdu Clay, however, are still debated. In the present work, the Chengdu Clay and adjacent loess from the eastern Tibetan Plateau, the Chinese Loess Plateau and the Qinling Mountains were investigated. The content and grain size distribution of quartz, quartz $\delta^{18}O$, Sm–Nd isotopic system, rare earth elements and other trace element concentrations for the Chengdu Clay and its adjacent loess were analyzed. Based on comparison and spatial variation analysis, the results confirm that the Chengdu Clay is of aeolian origin. The dust provenance of the Chengdu Clay differs from those of the adjacent loess. The Chengdu Clay is possibly of local origin and is transported by an ancient katabatic wind over a short distance during glacial and stadial periods. The alluvial sediments in the northwestern Sichuan Basin are possibly the major sources of the Chengdu Clay. There is little possibility of an effective aeolian transport bringing dust from the Tibetan Plateau, the arid area in northwestern China or Inner Mongolia into the Sichuan Basin, where it may be deposited to form the Chengdu Clay. Thus, long-range dust transport by the East Asian winter monsoon, the westerly jet or the Tibetan Plateau winter monsoon possibly plays a minor role in controlling the magnitude of the dust flux of the Chengdu Clay in the Sichuan Basin.

1. Introduction

The Chengdu Clay (Chengtu Clay; CDCL) was named by Thorp and Dye in 1936. According to the description by Thorp and Dye (1936), the Chengdu Clay is characterized by the following properties: (1) distributed in the western and northwestern parts of the Sichuan Basin (Szechwan Basin), (2) near surface outcrop, (3) covering the second and higher terraces or rocky hills, (4) no stratification, (5) no columnar structure, (6) containing calcareous concretions, (7) no gravel or pebble, (8) moderately or slightly acid to neutral reaction, (9) yellow sticky and plastic clay, (10) weathered after deposition, (11) formed in the late Pleistocene, and (12) possible aeolian origin.

Thorp and Dye (1936), Salfeld (1936), and additional investigators (Chu, 1937; Thorp, 1939; Richardson, 1942, 1943; Ma, 1944; Liu, 1983; Shao et al., 1984; Fang, 1995; Feng et al., 2010, 2011; Hu et al., 2010; Yang et al., 2010a, b) confirm that CDCL is possibly a weathered aeolian deposit. In contrast, Young (1937) and other researchers express different opinions regarding the aeolian origin of CDCL (Yü, 1940; Hseung, 1944; Li, 1947; Li et al., 1964; Zhou, 1986; Zhang, 1988; Kong, 1994). Moreover, the original relationships among the CDCL, the loess of the eastern Tibetan Plateau (ETPL), the loess of the Chinese Loess Plateau and the Qinling Mountains (Tsinling Mountains; LPQL), and their potential source areas are still debated (Thorp and Dye, 1936; Thorp, 1939; Richardson, 1942, 1943; Ma, 1944; Lu et al., 1976; Shao et al., 1984; Fang, 1995; Wang, 1998; Wang et al., 2002; Feng et al., 2010, 2011; Hu et al., 2010; Yang et al., 2010a,b). Accordingly, the wind systems for dust transport in the Sichuan Basin are also a debated problem (Fang, 1995; Feng et al., 2010, 2011; Han et al., 2010; Hu et al., 2010; Yang et al., 2010a,b).

Aeolian deposits are very important for understanding soil genesis, aeolian dust aggradation, wind erosion, palaeoclimate, source-area aridity and plant cover (Rea, 1994; Derbyshire et al., 1998; Muhs and Bettis, 2000; Stuut et al., 2009; Maher et al., 2010). A large number of studies focusing on the aeolian deposits in Asia, particularly in China, have been reported so far (Liu and Chang, 1964; Heller and Liu, 1982; Liu, 1985; Kukla et al., 1988; Porter and An, 1995; Derbyshire et al., 1997), but the investigations on the aeolian sediments in the Sichuan Basin are relatively few (Zhao et al., 2007; Han et al., 2010; Yang et al., 2010b). In addition, the investigations of the aeolian sediments in the Sichuan Basin may shed light on whether or not the Tibetan Plateau is an important dust source for long-range transport in Asia (Clarke, 1995; Fang, 1995; Zhang et al., 1996, 2001; Lehmkuhl et al., 2000; Fang et al., 2004; Lu et al., 2004; Sun et al., 2007a; Han et al., 2008; Kapp et al., 2011).

The objectives of this study were to investigate (1) the original relationships between CDCL with adjacent loess (ETPL and LPQL); (2) the

* Corresponding author at: Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Building 3, 16th Lincui Road, Chaoyang, Beijing 100101, China. Tel.: +86 10 84097095; fax: +86 10 84097079.
E-mail address: fengjl@itpcas.ac.cn (J.-L. Feng).

http://dx.doi.org/10.1016/j.catena.2014.04.018
0341-8162/

transport mechanism and potential source areas of the CDCL; and (3) the meteorological conditions and wind regime responsible for CDCL formation.

2. Background

2.1. Geographical conditions

The current study area lies in the northwestern Sichuan Basin and adjacent areas (Fig. 1). The Sichuan Basin (450–650 m asl–above sea level) is one of large basins in China, and is surrounded by the eastern Tibetan Plateau (2000–4500 m asl) to the west, the Yunnan–Guizhou Plateau (1400–1800 m asl) to the south, the Huaying Mountain (800–1000 m asl) to the east and the Qinling Mountains (2000–3000 m asl) to the north. Moreover, the Qinling Mountains, with east-to-west orientation, border the Chinese Loess Plateau to the north. The seismically active Longmen Mountains (Lungmenshan Mountains) thrust belt is located at the margin of the eastern Tibetan Plateau (Fig. 1C).

The Sichuan Basin consists of low hills and alluvial plains. Several major rivers, including the Minjiang River, Jialingjiang River, Tuojiang River and Fujiang River, flow into the northwestern part of the basin

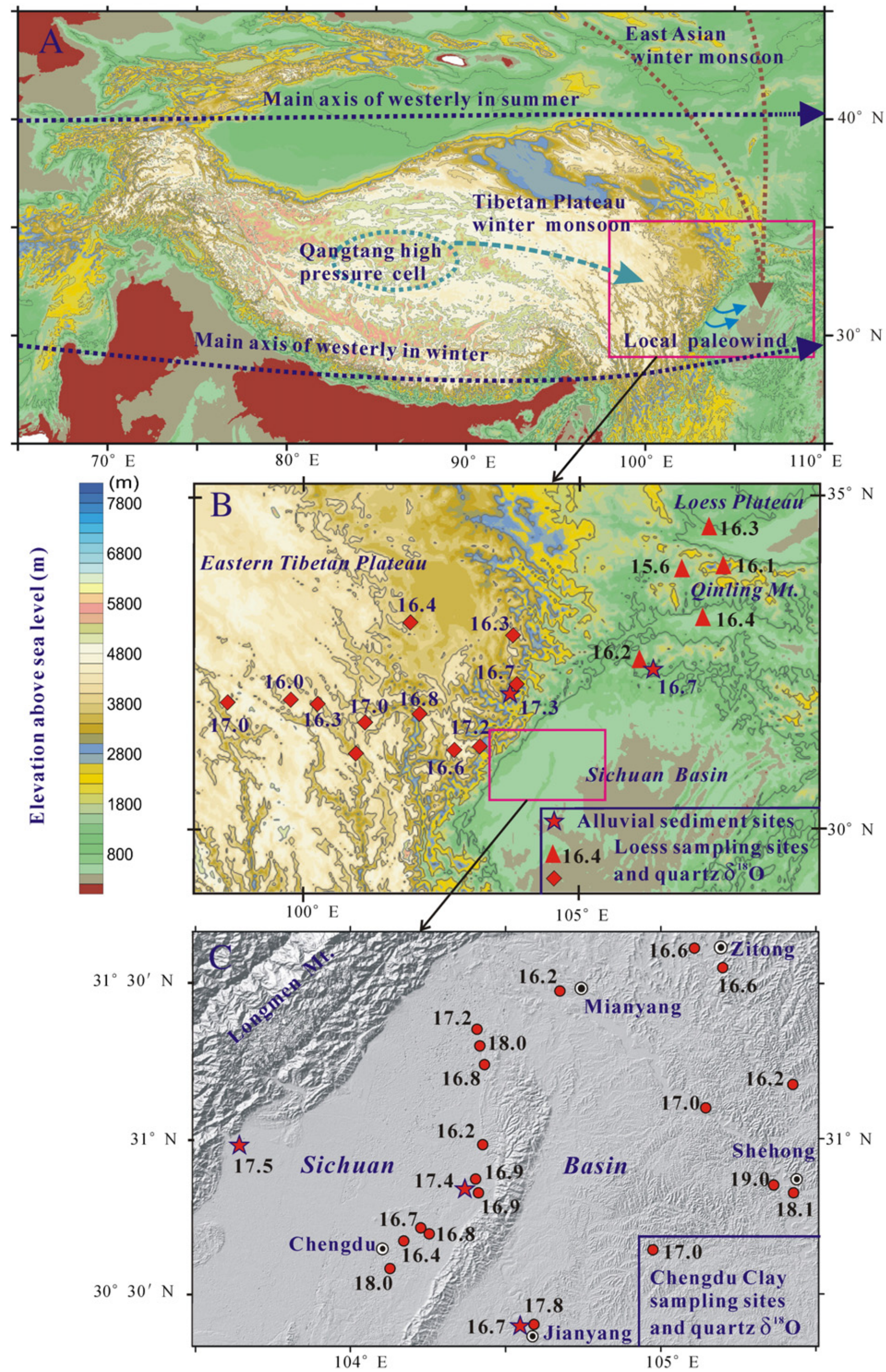

Fig. 1. A. Sketch map showing the topographic features and the potential atmospheric circulation for aeolian dust transport (main axes of the westerly jet are modified after Schiemann et al., 2009); B and C. sampling sites and the $\delta^{18}O$ values of quartz in the Chengdu Clay and adjacent loess.