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A review of glacial sequences of the Kunlun Pass, northern Tibetan Plateau

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Abstract

In the Kunlun Pass area of northern Tibet, glacial landforms and sediments provide evidence for three major Quaternary glaciations. ESR and TL dating suggest that they date to 600–700 ka (Wangkun Glaciation), ~260 ka (Yakou Glaciation) and 61–13 ka (Yuzhufeng Glaciation/ the Last Glacial). Each glaciation is less extensive than its predecessor. The Wangkun Glaciation is the largest Quaternary Glaciation. The extent of the glaciers during the Wangkun Glaciation was 3–5 times larger than that of the present glaciers. During the Last Glacial, glaciers advanced several times. The moraines near the modern glaciers are probably the products of Neoglaciation and Little Ice Age.

1. Introduction

The timing and extent of Quaternary glaciations in Asia is controversial (Zheng, 2000; Owen et al, 2002a,b; Zech et al., 2003). Since Chinese scientists first investigated Mount Everest and constructed glacial sequences in the 1960s (Zheng and Shi, 1976), numerous glacial investigations in the Tibet Plateau have been undertaken and many local glacial sequences have been reconstructed. Zhou and Li (2001) reviewed the current knowledge about the timing of the late Quaternary Glaciation in Tibet. The limited extent of each glaciation in many mountains, e.g., Himalaya, Nianqingtangula and Bayan Har mountains (Li et al., 1986; Zhou and Li, 2001; Owen et al., 2002a,b; Yi et al., 2002), shows that Tibet was not covered by a large ice sheet during the Last Glacial Maximum (LGM) as proposed by Kuhle (1998). The glacial history on the Tibetan Plateau has been correlated with the plateau's uplift. There is dispute, however, as to when the Tibetan Plateau was uplifted to its present elevation. Some scientists believe the plateau was uplifted to its highest average elevation 14 Ma, and decreased or maintained its height afterwards (Turner et al., 1993; Coleman and Hodges, 1995; Searle, 1995). Others believe that the Plateau reached its present elevation later, at ~8 Ma (Harrison et al., 1992, Cerling et al., 1993; Quade and Cerling, 1995; Meyer et al., 1998; Tapponnier et al., 2001). In contrast, some researchers believe that the most recent uplift of the Tibetan Plateau took place 3.4 Ma, and that the plateau reached an elevation of 4500 m above sea level (asl) in the Quaternary (Li et al., 1979; Ding et al., 1995; Cui, 1996). Our research on the geomorphological evolution of the Kunlun Pass area suggests that the most recent uplift occurred during the Early to Middle Pleistocene (Cui et al., 1998; Wu et al., 2001). This paper examines the glacial history in the Kunlun Pass and postulates on the relationship between tectonics and glaciation.

The Kunlun Pass (Fig. 1) is a key region in understanding the uplift and environmental change in the Tibetan Plateau, because it is situated in the transitional zone between the Qaidam basin and the interior of the 12 Tibetan Plateau. The Kunlun Fault and Xidatan Fault pass through the Kunlun Pass area, which is an ideal site for studying tectonic activity (Coward et al., 1988; Kidd and Molnar, 1988; Cui et al., 1998) and earthquakes (Van Der Woerd et al., 2004; Wang et al., 2004). In addition, it also provides well-preserved late Tertiary stratigraphic

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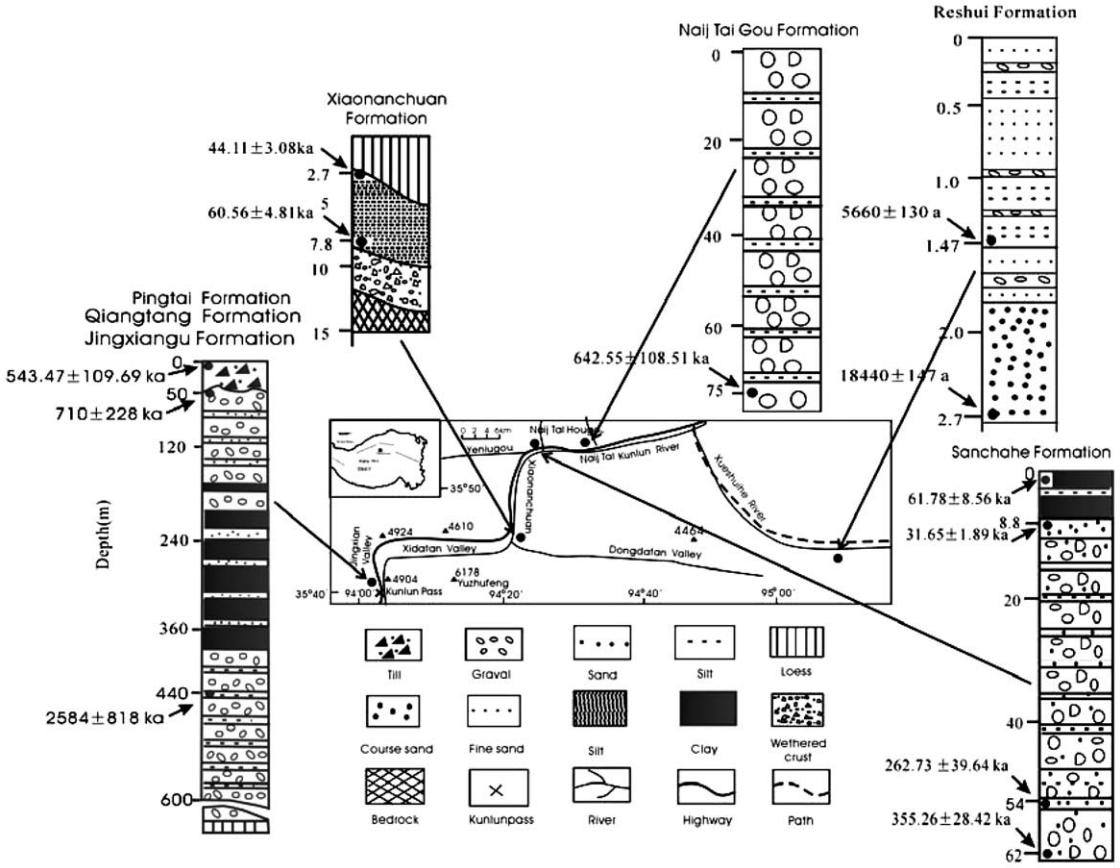

Fig. 1. Map of the Kunlun Pass area showing five sedimentary map and study sites. Depths of dated samples are indicated.

sequences and well-developed glacial deposits and erosion forms (Wu et al., 1996; Liu et al., 1997a,b; Cui et al., 1999). The glacial sequences here have also received attention. Wu et al. (1982) recognized six glaciations based on the sediments in the Kunlun Pass area. Kidd and Molnar (1988) believed that one glaciation probably occurred 1.5–2.4 Ma. Li and Jiao (1990) identified three Pleistocene glaciations. However, the timings of glaciations were confused because glacial and non-glacial diamictons are not adequately distinguished.

This paper reviews the research, aiming to describe and interpret the glacial landforms, landform evolution and sediments of the Kunlun Pass area of the Burhan Budai Shan in the Kunlun Mountains, to identify the glacial and non-glacial diamictons and to reconstruct the glacial sequences. The glacial history is compared with others in the Tibetan Plateau, as well as with the loess records of the Loess Plateau (Liu, 1985) and the marine oxygen isotope (MIS) records (Nelson et al., 1985, 1986).

2. Glacial stratigraphy in the Kunlun Pass area

The Kunlun Pass area, between the Qiangtang Plateau and the Qaidam Basin, is situated in the east Kunlun Mountains (Burhan Budai Shan, at 35°40′N, 94°02′E)

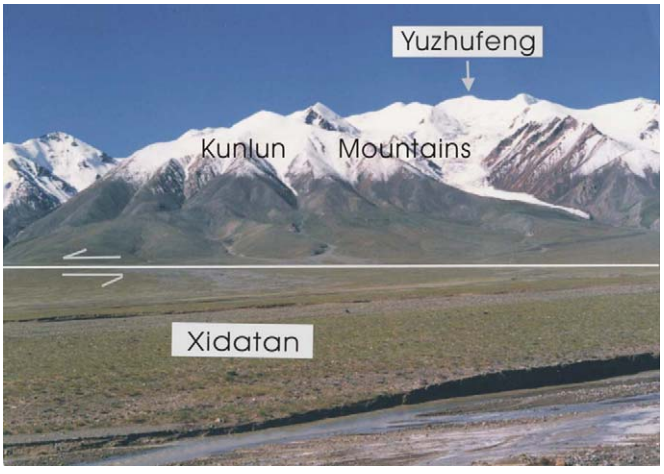

Fig. 2. Views of the Xidatan Valley at ~4200 m asl. The left lateral strike slip fault (Xidatan Fault) is shown by the white line.

(Fig. 1). The Xiadatan and Kunlun strike-slip faults divide the Kunlun Pass area into three geomorphic units:

(1) The high mountain section, including the Kunlun and the Buerhan Budai Mountains. The highest peak of the Pass area is the Yuzhufeng (in the Buerhan Budai mountain; Fig. 2). With an elevation of 6178 m asl, it