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An Attempt to Date the Salt-mounds in the Lop Nor Playa

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1 Introduction

The Lop Nor playa, located in the eastern end of the Tarim Basin, capped with a thick salt crust covering an area of approximately 5,500 km^2 (Ma 2007) that closely resembles a "Great Ear" in satellite images. Understanding the formation of the salt crust can provide important information concerning wind erosion in the region and evolution of the Lop Nor playa. Therefore, dating of salt crust is crucial to reveal the interaction of wind erosion, dust supply and geomorphologic development. However, there is no good dating method applied to determine the age of the youngest salt-crust sediments (Olsson 1973; Olley et al 1997; Luly et al 1986; Murray and Olley 2002) as they contained no carbon-rich materials (wood or charcoal were originally living vegetable matter). We recently identified and dated salt mounds that were widely distributed on the surface of Lop Nor saline pans. This may provide a new way to estimate the age of salt crusts within saline playa.

2 Results and Discussion

It has been suggested, based on the results of the C_{14} dating of a lake sediment core from the Lop Nor Basin, that the arid climatic conditions developed in this area ~3800 yr BP (Ma et al., 2007), resulted in saline deposits, a seasonal saline lake and saline pans. However, the Lop Nor typically experienced recurrent cycles of expansion, contraction, and desiccation during the last several thousand years (Wang, 2001; Yuan and Yuan, 1998), leading to repeated dissolution and recrystallization of the salt pans in alternating periods of flooding and desiccation. The last record of refilling water in the Lop Nor basin was documented by Parker Chen, who reported a water body of ~ 2400 km^2 in the centre of the "Great Ear" area in 1934 (Cheng, 1936), whereas, the earliest satellite images, the Corona photographs showed that the Lop Nor Lake had completely dried up in 1961(Zhong et al., 2008). This indicates the age of the saline pans in most inner "Great Ear" rings is just ~50 years (Li et al., 2008). However, the exposure age of saline pans in other area in the playa remains unknown.

The eastern area of the Lop Nor playa is characterized by extensive distribution of active salt mounds (Zhong et al., 2008), about 1-2 m high and 3-15 m across, with a humid surface and dome-shaped top, which generally show up as the dark tone in the satellite images. However, field investigations in most parts of the "Great Ear" salt pans are constrained by poor accessibility. The salt mound described in this paper was 12 m in diameter and approximately 1 m high. The salt mound deposits are caused by the long-term eruption of underground springs, and could be taken as an indication that dry saline pan environments have existed in the past. The upwelling and discharge of brine springs play an important role in controlling the growth of salt mounds. Once highly concentrated groundwater brines are forced to the surface, the abundant attendant salts were precipitated, and the end-member mineral, picromerite ($K_2Mg(SO_4)_2 \cdot 6(H_2O)$) has been found in efflorescent salts with halite at the top of salt mounds. The humid surface of these salt mounds tends to readily trap windblown sand and dust. The resulting deposits consist of alternating layers of salt and mud. The long-term vertical repetition of the salt-mud sequences leads to continued growth of the salt mounds.

The Cs_{137} technique is used to measure the accumulated age and estimate deposition rates of the salt mound in this research. It is well know that the radioactive Cs_{137} does not occur naturally on earth and was formed atmospherically by nuclear testing that occurred during the period extending from the mid 1950s to the late 1970s. When Cs_{137} settled it rapidly fixed in the surface soil of most environments, which thus provides a good way of measuring recent soil erosion-deposition rates (Walling and He, 1998; Aslani et al., 2003; Zhiyanski et al., 2005).

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The Cs_{137} accumulation was observed in the top 0-9 cm of the salt mounds and the radioactivity show a range varying from 0.83 to 5.48 PBq.kg-1 (Fig. 1). The result suggests that this salt mound accumulated ~9 cm since the mid-1950s when the first global fallout of bomb-derived radiocesium occured, which equates to a mean deposition rate of ~ 0.16 cm/yr. Therefore the ~1 m high salt mound would take ~600 years to build up at this deposition rate. Because these salt mounds are readily dissolved during local flooding, this indirectly reflects that a dry saline pan environment has existed for ~600 years. Accordingly, numerous moist salt pans cover the Lop Nor salt flats at the present time, which are caused by groundwater brine discharge, suggesting an active growth phase of salt pans. The same Cs_{137} methodology can be used to estimate the deposition rates and accumulated age of salt pans within different area of the “Great Ear”playa.

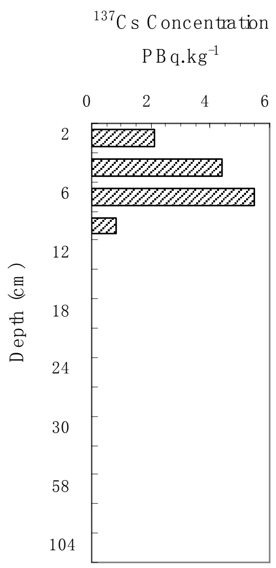

Fig. 1. The depth distribution of Cesium-137 concentration in the salt mound.

The Lop Nor is a large, active, groundwater-discharging playa, in which groundwater discharge commonly occurs accompanied by the accumulation of aeolian-derived sediments, and is a naturally steady depositional environment with little precipitation (<20 mm/yr). Additionally, the radioactive fallout of Cs_{137} was deposited universally across the Lop Nor salt flats, and is present in relatively high abundance attributed to Chinese nuclear tests near the Lop Nor basin beginning in the 1960s. Therefore, the use of Cs_{137} is feasible as a sedimentary marker to determine deposition rates and accumulated age in this area. It also could provide a new way of dating young saline sediment with specific accretion cycles, most of which are related to groundwater and spring discharge in modern playa environments.

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