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Luminescence dating of ancient Darhad basin, Mongolia

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Darhad basin is located in the northern Mongolia, in the western end of the Baikal Rift Zone. In contrast to the neighboring Lake Hovsgol, Mongolia's largest and deepest lake, the Darhad is a drained lake basin. It is ∼100 km long (north-south), 20-40 km wide and covered by sediments which locally exceed 500 m thickness (Zorin et al., 1989). Darhad basin is characterized by alternating episodes of expansion and desiccation that are closely related with the Pleistocene damming events. Previous studies of the Darhad Basin suggest that the last paleolake was dammed by a large glacier or the sediments (Selivanov, 1967, 1968; Krivonogov et al., 2005; Gillespie et al., 2008). Especially, recent expansion of the paleolake might be caused by the two glacial maxima during MIS 4 and 2. However, glacier-dammed lakes might be short-lived, dried up and permafrost occurred in the drained basin during the Holocene period. The uppermost paleolake sediments (13.2 m depth) are exposed following the curvature of the meandering river (called "Hodon outcrop"). It is considered the most likely site for the youngest paleolake sediments because it is distributed in the northern middle part of the paleolake. Krivonogov et al. 2012 described the Hodon outcrop with the sedimentological and chronological data. Age dating of 16 samples (11 mollusk shells, 5 wood fragments) indicated that Hodon outcrop sediments were deposited between 10.1±7 and 4.9±5 ka. However, the ages obtained on shells much older dates than the matched wood samples because of ingestion of old carbon by mollusks. The age difference between shells and wood fragments is a minimum of 1.73 ka and a maximum of 3.41 ka (average 2.5 ka). In this case, 14C ages from shells should be corrected with appropriate correction factor. However, the old carbon effects could vary temperally and spatially in the Darhad paleolake. The limited number of the 14C ages from wood fragments result in a simple linear trend in the depth-age curve. Thus, age control on existing 14C ages from this site is limited, chronological interpretation based on the 14C ages is still incomplete in Hodon outcrop sediments. OSL (Optically Stimulated Luminescence) is an alternative method for dating to overcome the problems associated with 14C methods. OSL has been extensively used for dating arctic sediments (Thomas et al., 2006; more). Previous optical ages on Darhad paleolake sediments obtained using IRSL (Infrared-stimulated luminescence) on feldspars (Gillespie et al., 2008; Batbaatar et al., 2009). Feldspar has much brighter luminescence than quartz, while the OSL signal of feldspars bleaches at least one order of magnitude slower than the OSL signal of quartz (Godfrey-Smith et al., 1988; Huntly and Lamothe, 2001; Mauz and Bungenstock, 2007; Kim et al., 2012). In glaciofluvial, glaciolacustrine environments, inadequate bleaching of the OSL signal is known to be a potential problem of burial ages (Thomas et al., 2006). OSL dating of permafrost deposits may also involve uncertainty about the inhomogeneous radiation field surrounding the dosimeter and the absorption of ionizing energy alternately by water and ice in a not-constant pore volume (Haeberli et al., 2003). In this study, we test the applicability of quartz OSL dating for the uppermost paleolake sediments in the Hodon outcrop of the Darhad basin. The OSL results were systematically compared with additional radiocarbon ages from wood fragments to conclude the reliability of the OSL dates and to construct intensive chronology for Late-Pleistocene Darhad paleolake. To evaluate the time of recent expansion of the paleolake, the northern piedmont (Talyn outcrop) of the basin was dated by OSL.