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Anomalous isotopic composition of carbonates from Quaternary evaporitic deposits, Western Qaidam, China: evidence for thermogenic derived methane

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The Himalayas, the Tibetan plateau and the adjacent mountains north of the plateau, are the most outstanding present-day topographic features resulting from continent-continent collision. The average elevation of the region reaches 4000-5000 meters, the progressive south-north shortening due to collision achieving ca. 1400 km. The Neohimalayan tectonic phase had started during early Miocene, and was followed by accelerated denudation within the past few million years.

The Qaidam basin is located at the northern edge of the Tibetan plateau. The thick Pliocene-Quaternary sediments were monitored by tectonic processes related to uplift of the Tibetan plateau as well as by climatic changes related to the plateau growth. The ca. 120.000 km^2 large, rhomb-shaped Qaidam basin, with unusual thick Mesozoic to Cenozoic sedimentary sequences of 3 to 17 km, is surrounded by the Kunlun/Qimantagh, Qilian and Altyn mountain ranges. Mean surface elevation of the basin floor is ~2700 m, whereas the surrounding mountains as Kunlun-, Altyn- and Qilian Shan reach elevations above 5000 m. Latest interpretations consider the formation of Qaidam basin in response to oblique compression between the left lateral Altyn and Central Kunlun faults.

The present climate represents the driest part during the last 40 ka with mean annual precipitation of 25 mm in the centre of the basin and 50 mm along the border. Mean annual evaporation is ~3000 mm, while annual average temperatures are 2 to 4°C. The landscape is characterised by salt lakes, playas and aeolian landforms. There are still 27 salt lakes occupying an area of approximately 1500 km^2. Playas and the salt lakes as for

example Yiliping and Quarhan cover about one quarter of the total basin area.

Stable isotope analyses on carbonates from lake evaporates collected from the non-marine Qaidam basin yield a positive excursion from Pliocene to Quaternary times. The positive shift in $\delta^{18}O$ values between the Pliocene and the Quaternary is interpreted as a climatic change from relatively humid conditions to arid conditions. Such high aridity conditions and a closed lake environment were deduced for Quaternary from other proxies like e.g. the widespread salt-deposits and pollen distribution.

At Dafeng Shan, situated in the western part of the basin, the Quaternary sequences are composed of alternating layers of celestine/dolomite and aragonite/calcite with distinct isotopic compositions. The occurrence of celestine indicates, highly saline fluids, with significant concentration of dissolved sulphate These waters could penetrate in underlying sediments leaching pre-existent carbonates or evaporites. Sr solubility decreases with temperature, so, low-temperature fluids were required for transport. The oxygen isotopic compositions of carbonates vary between +4 and +9‰ (PDB), representing the heaviest measured since now. The extreme high $\delta^{18}O$ compositions support also a strong evaporative, closed lake, where such high salinity fluids could develop. The carbon isotopic compositions of carbonates show a large negative excursion of up to 30‰. Microfabrics, mineralogy as well as isotopic compositions suggest recycling of carbon from thermogenic derived methane.

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