SALINE LAKES ON QINGHAI-TIBET PLATEAU AND SALTS ON MARS[1]

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The Qinghai-Tibet Plateau stands in the east of Asia, with an area of ~2.5 million km^2 and an average elevation of ~4500 m, and its general terrain slopes from northwest to southeast. It is a unique physico-geographical unit and also the youngest plateau on the Earth. Although divergent views exist as to the timing of its largest-amplitude uplift, both Chinese and foreign scientists think that the plateau originated in the Late Cenozoic [1, 2] and up to now the uplift of the plateau has not ceased.

The geological history of the Qinghai-Tibet Plateau may track back to the Precambrian (800 Ma BP). During the Early Permian at 290 Ma BP, except in the Altyn Tagh Mountains in the north, the great majority of the Qinghai-Tibet region was a vast sea, connected with the seas of Central, West and South Asia, called the Tethys Sea. From the late Early Permian on, the land of the region expanded progressively from north to south. As early as the Early Triassic at 250 Ma BP, the Qaidam basin in the north of the plateau had emerged from the sea and became land. Southward to southern Tibet, water of the Neo-Tethys Sea completely retreated westward during the middle Eocene at 30 Ma BP. Now there are more than 2000 lakes of varying size on the Qinghai-Tibet Plateau, which formed by geological-geochemical evolution after the plateau became land, and its salty materials were mainly derived from weathering of rocks and deep-seated hydrothermal water, implying the features of tectonically active belts of plateaus on the Earth [3].

The Qinghai-Tibet Plateau accounts for 1/3 of the height of the atmospheric convection layer and low temperatures are the necessary result of its extremely high relief. The temperature contours of the plateau assume the shape of concentric circles with northern Tibet as the center. The average annual temperatures of northern Tibet range from -8 to -6℃, and those of western Qaidam are -4℃ [4].

The high level of solar irradiation causes the rapid rise of surface temperatures after sunrise; after sunset, the thin atmosphere and scarce impurities contained in moisture, easy dissipation of heat from the surface and rapid temperature lowering cause great diurnal temperature variations of the plateau. For example, the extremely low minimum temperature of Lenghu Lake in the northwest of Qaidam is -34.4℃, while the extremely high maximum temperature is 34.2℃. Furthermore, the seasonal temperature difference (up to 34℃) of the plateau also centers on the northwest of Qaidam.

The annual precipitation of the plateau decreases from southeastern Tibet to northwestern Tibet, and in the northwest of the Qaidam basin it is only below 20 mm; the annual aridity is 50 (Fig. 1) and locally up to 100.

Controlled by the geochemical and climatic conditions, chemical types of lakes on the Qinghai-Tibet Plateau are divided into the east and west parts and distributed in four zones and one region (Fig. 2). Mg-sulfate subtype lakes are distributed in the Qaidam basin and Hoh Xil. In the saline lakes there, e.g. Dalangtan Playa, Da Qaidam Lake, Xiao Qaidam Lake and Gas Hure Lake, except that large amounts of halite, gypsum, carbonate and mirabilite were found, Mg-sulfate-bearing minerals such as epsomite, hexahydrite, starkeyite, bloedite, picromerite and anhydrokainite were also identified, and additionally large amount of opal was found in thermal fields of Tibet.

Mars is characterized by such extreme climatic conditions such as great temperature variations, thin atmosphere and aridity. Now Mg-sulfate monohydrate, gypsum, chlorite, carbonate and opaline silica have been found on Mars [8-10]. Therefore the aforesaid geochemistry and climatic conditions forming saline lake minerals of Mg-sulfate subtype in the west of the Qaidam basin, Qinghai-Tibet Plateau, and geothermal deposits in Tibet may provide an analog on Mars for understanding the formation of Martian salts and opaline silica and features of their surface processes.

[1] Note: “Aridity Index (AI)” determined by United Nation Environment Program (UNEP), AI =P/PER, where P is average annual precipitation, PET is the potential evapotranspiration。

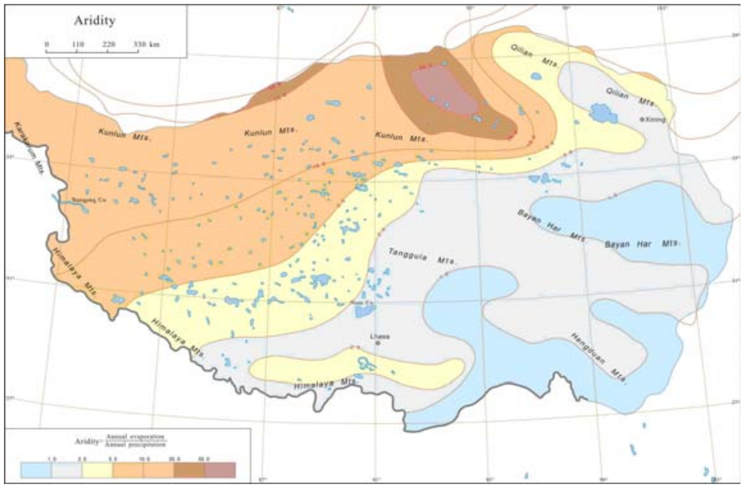

Fig. 1. Annual aridity of the Qinghai-Tibet Plateau [5].

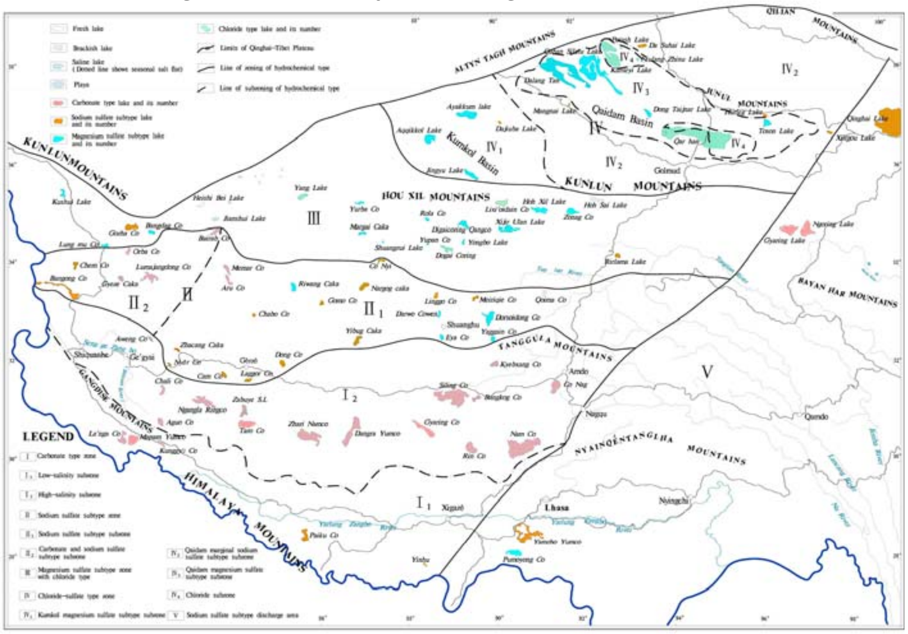

Fig. 2. Distribution of hydrochemical zones of salt lakes on the Qinghai-Tibet Plateau.

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