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## Study on limestone horizontal corrosive grooves in karst depressions

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This study simulates the corrosive effects of water on the development of horizontal karst grooves with an alogous cases to the karst depressions in Yunnan Shilin area, China, by using testing pillars made of Calcium oxide powder (CaO) and halite (NaCl), respectively. Experimental results show that semi-circular bottleneck-shaped horizontal grooves, annular bottle neck horizontal grooves, inclined grooves, and dual-layered horizontal grooves formed, respectively, under the environments of moving water of lake, canal, stagnant water lake and karst wetland(fig1). No grooves developed in the soil layer along the lake shore high concave Slopes. Moreover, the growth rate of horizontal solution grooves in halite pillar(i.e.1.2-4.56cm/h) was much higher than that of calcium powder one (as 0.0004-0.0089cm/h). Meanwhile, in the pillars of same materials, the solution groove growth rate in flowing water was 3-22 times as much as that in stagnant water; and the rate in water was two times as much as that in soil with normal moisture content. There are diverse types and extremely large quantity of solution grooves developed in the karst depressions and karst Lakes & wetlands in the Shilin area.Among them,the horizontal grooves, with the shapes of semi-circular bottleneck, annular bottle neck and annular half curved face,respectively reflect the fluctuated water environments as lake shore and central areas of lake & wetland, where the measured average depth of the solution grooves is  $63.95 \pm 33.40$ cm with significant differences with sites and altitudes. The average corrosive rate of solution grooves can usually be presented by the difference value of the integrated corrosive rate of carbonate rocks ( i.e., $135 \text{ mm} \cdot \text{ka}^{-1}$ , or 1.5 times of the chemical dissolution rate of the carbonate rocks) and the air-rock interface' s corrosive rate (i.e. $5.2 \text{ mm} \cdot \text{ka}^{-1}$ ), from which the growth time length of the horizontal groove can be sorted out. As a result, the mean growth time length of the limestone horizontal grooves in the Shilin karst depression area is about  $4.92 \pm 2.573$ ka. Accordingly, it can be speculated that the horizontal grooves were initially produced around five thousand years ago at the rock bottom in the karst depressions; at that beginning stage, the areal density of the karst lakes & wetlands was 16% in this area which Be longed to karstlake/wetland plateau landform with a year-round humid and high rainfall climate. However, at present,the density has been reduced to only 0.5% due to the dramatic change in the areal size of lakes & wetlands, which also implies the heavy impact of climate change and intensive human activities on the karst environment.

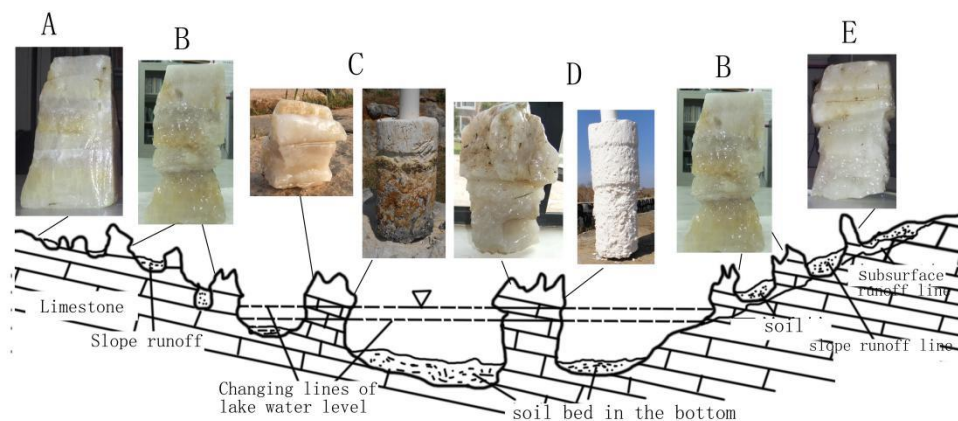


Fig.1 The groove types on rock pillars and their locations in the lake

A:No grooves developed in the soil layer;B:semi-circular bottleneck-shaped horizontal grooves;C annular bottle neck horizontal grooves;D:dual-layered horizontal grooves;E:inclined grooves

