



Experiments on the formation carbonate “cyclic steps” as a model of travertine step-pool morphology

Tatsuya Shitanishi (1), Miwa Yokokawa (1), Wonsuck Kim (2), Norihiro Izumi (3), and Gary Parker (4)

(1) Faculty of Information Science and Technology, Osaka Institute of Technology, Hirakata, Osaka 573-0196, Japan, (2) Department of Geological Sciences / Institute for Geophysics Jackson School of Geosciences, University of Texas, Austin, TX 78712-0254, USA, (3) Division of Field Engineering for the Environment, Faculty of Engineering, Hokkaido University, North 13, West 8, Kitaku, Sapporo 060-8628, Japan, (4) Dept. of Civil & Environmental Engineering, Dept. of Geology, University of Illinois Urbana Champaign, Urbana, IL 61801, USA

A train of steps similar to those observed on the river bed and the ocean floor are sometimes observed on the limestone surface as well. Those cyclic steps are not formed by the interaction between sediment and flow, but formed by boundary instability between flowing water and a limestone substrate associated with precipitation and solution of limestone due to chemical and biological processes. It is suggested that they correspond to “cyclic steps” or “step-pool” morphology observed at the interface between fluid flow and the transportational and/or erosional substrates, such as sand and gravels and/or bedrock respectively, formed by deposition and erosion at the upper-flow regime in the Froude sense. Although field observations of the limestone step configuration are widely known, there have been very few theoretical and experimental study for the formative condition and mechanism of these carbonate steps with flowing fluid. Here we operated flume experiments on the formation of carbonate steps by the precipitation from the flowing fluid.

We used a 1.8 m long, 5 cm deep and 2 cm wide flume made of acrylic boards at Osaka Institute of Technology. To give some roughness at the bottom of the flume we pasted the mixture of the acrylic adhesive and sand, 0.2 mm in diameter. To make the “source water” of the experiments, we immerse limestone pebbles into the distilled water, and add the Carbon dioxide by letting dry ice (frozen carbon dioxide) melt in it aiming to dissolve the limestone. In addition, we add the powder of Calcium hydroxide to the source water. The source water was input from the upstream end of the flume and recirculated into the tank of the source water. The values of pH and electric conductivity and the temperature of the source water were monitored, and dry ice, the powder of the calcium hydroxide and the distilled water were added arbitrary to keep the quality of the source water constant. The running time for each day was about 6-7 hours. From about 4 days after, porous veneer and small chunks of carbonate were observed on the bottom of the flume, and 5-6 days after steps were getting appeared. For the best of our knowledge, this is the first report of carbonate step formation in the experimental flume by the precipitation of the carbonate from the flowing fluid.