Evolution of Rajapur thermal spring (Maharashtra) through the Gugi granites (Karnataka), with an experimental approach

H. K. Singh[(1)]; Banambar Singh[(2)]; Yadvendra Kumar[(1)] and D. Chandrasekharam[(1)]
(1) Department of Earth Sciences, Indian Institute of Technology Bombay, Mumbai -400076, India
(2) IITB-Monash Research Academy, Indian Institute of Technology Bombay, Mumbai -400076, India
E-mail: hemantkrsingh25@gmail.com

Abstract:
The evolution of Rajapur thermal spring, together with the experimental result on the granite-water interaction at 100 °C, indicate that Precambrian granites are main heat source for the Rajapur thermal water. These thermal waters are manifested in the form of springs, located in the west coast fault (India) and evolved through Gugi Archean granites.

Introduction:

Eighteen thermal springs are located along the west coast of India. These springs discharge through the Deccan Volcanic Province (DVP) but few of them show close relationship with the basement Precambrian gneisses and granites of the Dharwar craton (Ramanathan and Chandrasekharam, 1997). The present study mainly focouses on the Rajapur thermal spring whicih is located in high heat gernarating precambrian granites. These granites are placed below the Deccn volcanic flows and occurs as inlier within the basalt flows near Rajapur. A large outcrop of this granite is exposed near Gugi village in the state of Karnataka, India. these granites occur as inliers within the basalt flows near Rajapur. The nearest location where large outcrop of this granite occurs is near Gugi in the state of Karnataka, India. These granites are marked by the Gugi fault of a width of 500m and are reported with high U, Th content (Kumar and Srinivasan, 2002).

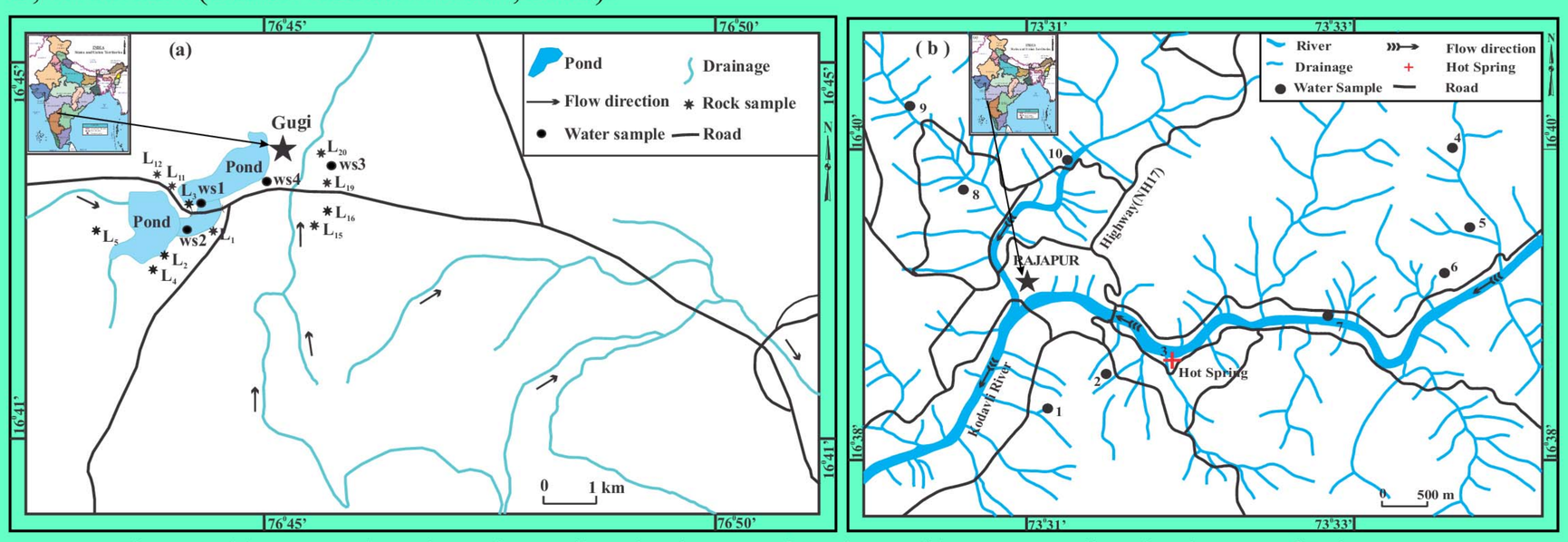

Figure 1- (a) water and granite rock sampling sites in parts of Gugi area, (b) water sampling sites in parts of Rajapur area.

The thickness of Deccan Flood Basalt (DFB) varies from 2500 to 3000m along the west coast and these are traversed by the large numbers of N-S trending faults and dykes (Hooper, 1990). West coast thermal springs are controlled by the major tectonic features, i.e. west coast fault (Chandrasekharam, 1985; Minissale et al., 2000). Variation of the geothermal gradient from the boreholes is observed about 57°C/km (Chandrasekharam, 2000).

Late Archean granitoids constituting the basement for the Neoproterozoic Bhima Group are exposed along the southern margin of the Bhima basin in southern India. This study aims at geochemical evolution of the Rajapur thermal spring using experimental leaching test of water rock interaction and geochemical signature of the surface water, groundwater and springs water.

Method of Study:

Rajapur area is dominated by the highly fractured Deccan basalt. Some places scoria and layering are marked in basalt formation. The hot spring is issuing water just beside the Kodavli River near the Unhale village, located at 3 km distance from main Rajapur city (Fig. 1b). Water samples from thermal spring, cold water spring, river, hand pump, dug well and pond were collected for the chemical analysis.

From the Gugi area, 15 granite rock samples were collected, out of which 5 representative grantine samples were selected for the water rock interaction experiment. The granite rocks were crushed to <1mm. The experimental leaching tests of water-rock interaction were carried out in a glass chamber with fluid/solid ratio of 10:1 and the temperature 100°C was maintained throughout the experiment. To mimic the natural system, rainwater is used in the experiment as the leaching fluid. The experiment was run continuously over a period of 30 days and the sample were collected on the dally basis. Average geochemical concentration of major ions present in the interacted water and rain water is given in Table 1.

Result and Discussion:

The major ion concentrations present in the water samples collected from Rajapur thermal spring and from Gugi area were plotted in Piper diagram (Fig 2). Water type of the Rajapur thermal spring is HCO_3 type. The surface water of the Rajapur and Gugi area fall in the Ca-HCO_3 type and there chemistry is compatible with rock through which they flow.

Table 1- Geochemical data for experimental leaching test

	A*	B**
pH	6.1	8.70
Na	0.03	0.96
K	0.005	0.08
Ca	0.15	0.36
Mg	0.078	0.25
Cl	0.09	0.13
SO_4	0.07	1.22
HCO_3	0.16	0.75

*A: meteoric water; **B: interacted water;
concentrations in epm

In experimental leaching test, the water samples derived from the granites showing wide range of geochemical variation. Most of the interacted water samples fall in the Na-SO_4 field, while the thermal spings of Rajapur and the surface waters fall in the Ca-HCO_3 field (Fig 2). This gives an indication that meteoric water circulating within the granites (host for thermal reservoir) are emerging through the Deccan basalt flows after mixing with the near surface groundwater rich in Ca & HCO_3 components. This again strengthens our earlier view (Chandrasekharam and Chandrasekhar, 2010) that the granites are the main source of heat for the thermal springs in several provinces of India.

Thus, the study clearly shows that the rain water circulating within the high heat generating Gugi granite is emerging as Ca-HCO_3 springs within the Deccan basalts near Rajapur.

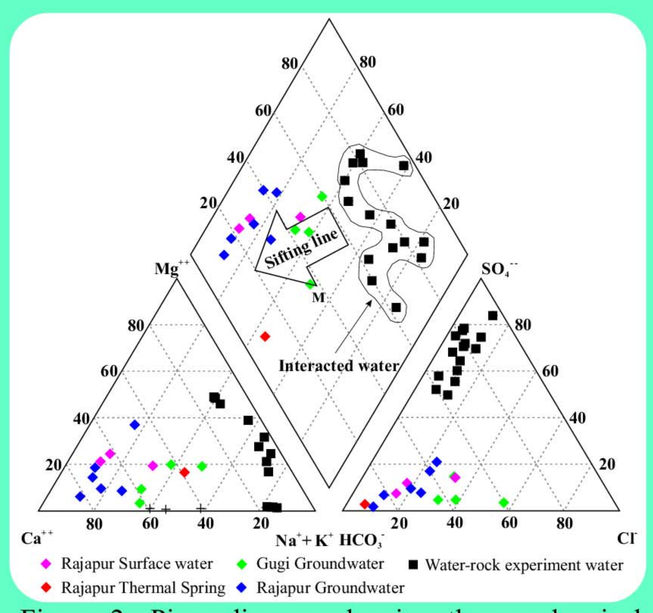

Figure 2- Piper diagram showing the geochemical charactoristics of water samples collected from Rajapur and Gugi area. Interacted water field represents the water samples from water-rock interaction experiment.

References:

CHANDRASEKHARAM D. (1985) - *Structure and evolution of western continental margin of India deduced from gravity, seismic, geomagnetic and geochronological studies.* Physics of the Earth and Planetary Interiors, 41, 186-198 pp.
CHANDRASEKHARAM D. (2000) - *Geothermal Energy Resources of India – Facts.* Proceedings Geothermal Power Asia 2000 Conference, Manila, 12-19 pp.
CHANDRASEKHARAM D. & CHANDRASEKHAR VARUN (2010) – *Geothermal energy resources, India: Country Update.* Proceding World Geothermal Congres, 1-11 pp.
HOOPER P. R. (1990) – *The timing of crustal extension and the eruption of continental flood basalts.* Nature 345, 246-249 pp.
MINISSALE A., VASELLI O., CHANDRASEKHARAM D., MAGRO G., TASSI F. and CASIGLIA A., (2000) - *Origin and evolution of 'intracratonic' thermal fluids from central-western peninsular India.* Earth and planetary sciences letters, 181, 377-394 pp.
PIPER M. (1994) – *A graphica procedure in the geochemical interpretation of water-analyses.* Am. Geophy. Union. Trans. 25, 914-923 pp.
RAMANATHAN A. & CHANDRASEKHARAM D. (1997) – *Geochemistry of Rajapur and Puttur Thermal Spring of the West Coast, India.* Journal of Geological Society of India 49, 559-565 pp.
SENTHIL KUMAR P. & SRINIVASAN R. (2002) – Fertility of Late Archean basement granite in the vicinity of U-mineralization Neoproterozoic Bhima basin, peninsular India. Current Scienc, 82, 571-576 pp.

Department of Earth Sciences
Indian Institute of Technology Bombay
Mumbai, India-400076