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Hydrogeological Characteristics in the Geothermal Springs in Sri Lanka
(A case study of the Madunagala and Kinniya geothermal springs)

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Geothermal springs are the natural springs that contain hot water. Hydro geothermal systems link the global lithosphere, hydrological and atmospheric cycles of the environment. Generally three important factors control the generation of hot springs, including heat sources, ground water and reservoir rocks. The major process of thermal water is the meteoric water that brings the heat from the interior to the surface through a permeable path or aquifer. The main heat source is from magmas within the crust that intrude to shallower levels from unstable areas such as active volcanic belts or fault zones

(Waring:1978). Groundwater is the main source of water, which is principally derived from rain and cool water on the surface that percolates to the subsurface along voids, fractures, joints, or faults of rocks.

Hot springs are found within two totally different geological units of Sri: Lanka. These hot springs or thermal springs are distributed along a narrow Eastern low land belt running from Hambantotata to Trincomalee and occur within the boundary of two main geological units – the Highland and Viyayan complexes (Dissanayake & Jayasena: 1987). 80% of hot springs are belong to the Vijayan complex and 20% to the Highland complex. These springs are surface manifestations of subsurface hidden heat (energy) sources such as a huge body of hot dry rocks, deeply extending fracture zones or concealed magma chambers (Fonseka: 1994). Dry hot rocks are naturally heated and crystalline rocks which lie beneath the surface areas where the geothermal gradient is two or three times greater than normal and it will be source of geothermal energy (Disanayake & Weerasooriya: 1985). If the heated water encounters some fracture leading upward it expands, becomes less dense and rises to the surface as hot water or steam, forming thermal water springs. However, Since Sri Lanka is not in an active volcanic or tectonic region of the earth crust, magma chambers can be ruled out. A hydrogeological study was conducted on two types of hot springs at Kinniya springs in Trincomalee and Madunagala springs in Sooriyawawa which are located in the Highland and Vijayan geological complexes. The research objective was to identify hydrogeological characteristics of the spring areas and identify physical and chemical characteristics of the hot springs. The Kinniya springs and Madunagala springs belong to the semi arid zones. Further, the Kinniya springs are located in the eastern coastal belt and the Madunagala springs to southern lower flat plains. The annual rainfall for Kinniya is 1200- 2000 mm and the Madunagala area receives 950- 1500 mm. The study area receives rainfall from both the southeast and northeast monsoons. Geological structures of the studied thermal springs were completely different. Geologically, quaternary unconsolidated alluvial deposits extensively covered the thermal springs areas and several small outcrops are exposed sporadically in and nearby the thermal springs.

Thermal springs water samples were collected in August and December 2009 and April 2010 to identify water quality parameters. Thermal water temperature was identified using the geo thermometer and electrical conductivity and pH was measured using the portable

EC and pH meter. The temperature and conductivity of spring water was measured directly in the field by a standard thermometer and Electrical Conductivity (EC) meter respectively. To determine the chemical properties of thermal water, laboratory analyses were carried out subject to cation and anions.

The surface temperatures of the Kinniya spring water range from 30 ºC to 37 ºC, all of which can be classified as warm springs. The spring water is classified as weakly basic as indicated by the invariable pH from 6.7 to 7.3. Conductivity of the Kinniya hot springs at 25 ºC shows insignificant variation ranging from 288 to 428 µS/cm (Table 2). In the surface temperatures of the Madunagala spring water range from 34 ºC to 46 ºC, all of which can be classified as warm thermal springs. The spring water is classified as weakly basic as indicated by the invariable pH from 6.8 to 7.9. The Conductivity of the hot springs at 25 ºC shows insignificant variation ranging from 6800 to 7890 µS/cm (Table 1). Further study reveals that due to increases of atmospheric precipitation decreases the thermal temperature decreases and a corresponding decrease atmospheric precipitation which defines increases the thermal water. Therefore, there is an existing intimate relation between atmospheric precipitation and thermal groundwater.

The chemical analysis results revealed that Kinniya spring water contains more HCO_3 and Madunagala spring water contained more Cl ions. Our geochemical analyses of Madunagala spring waters reveal that they belong to the Steam Heated water type with quite high contents of So_4 over recommended standards and the Kinniya springs belong to the mature water with high concentration of Cl (Chloride).

Well No:	December 2010		April 2011	
	Electrical Conductivity (µS/cm)	pH	Electrical Conductivity (µS/cm)	pH
01	294	7.2	371	6.7
02	288	7.1	340	6.8
03	296	7.0	343	6.6
04	305	7.2	369	6.8
05	298	7.3	369	6.9
06	308	7.3	428	6.8
07	306	7.3	362	6.9

Table 1. Electrical conductivity and pH variation in the Kinniya hot springs

Well No:	December 2010		April 2011	
	Electrical Conductivity (μS/cm)	pH	Electrical Conductivity (μS/cm)	pH
01	7100	7.7	7610	7.4
02	6900	7.9	7750	6.8
03	7200	7.9	7680	7.2
04	7100	7.9	7840	.6.8
05	7300	7.9	7890	6,8
06	6800	7.8	7780	7.1

Table 2. Electrical conductivity and pH variation in the Madunagala hot springs

Geologically Kinniya area belongs to Highland series and it's containing some calcium carbonate sediments. Using the Ternary diagram, the type of water identified and its reveals that Kinniya thermal groundwater belongs to chloride type and Madunagala thermal water consists the more SO_4. The study identified the temperature regime of the thermal springs and the results reveal that the Madunagala thermal springs water temperature is higher than the Kinniya spring water.

Key words: crystalline, geology, pH, Electrical conductivity, Vijayan complex, Highland complex

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Employing "Focus on Form" in the intermediate EAP classroom at the University of Colombo, Sri Lanka

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Background to the Study

The Level III program of English language proficiency courses in the Faculty of Arts at the University of Colombo was closely examined in the study. This program is very important as it is the only English for Academic Purposes (EAP) course which is accessible to the Arts students with low English language proficiency. At Level III, the students are taught discourse styles, reading strategies, note-taking skills, presentation skills, summarizing skills and vocabulary development strategies but explicit instruction in grammar is not targeted in the curriculum since it is assumed that those who end up in Level III do not need grammar instruction. Nevertheless, this assumption is not always correct as many students lack grammar knowledge and these students are in need of continuous grammar input to maintain and develop their proficiency.

Rationale

I have realized that the Level III students' metalinguistic awareness is weak and most of them cannot analyze their mistakes grammatically although they perform a variety of language tasks successfully in the EAP class. Thus, I personally have experienced to some