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The Specific Nature of Chemical Composition of Water from Volcanic Lakes Based on Bali Case Study

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Abstract

The research area was localized in the Indonesian Archipelago, at the latitude of eight and nine degrees S on the one of the Lesser Sunda group island provinces, Bali (563,3 km^2). Two massive calderas (Mount Batur 1717 m above sea level.; Mount Sangiyang 2093 m above sea level) are one of the most prominent landforms in the chain of volcanic mountain ranges of the Bali Island. Lake Batur (17,18 km^2) and Batur Spring (which are part of the freshwater lake system of Mt. Batur caldera) and also Danau Bratan Lake (one of the unconnected lakes next to the Mt. Sangiyang caldera), were selected for studies on the pollutants concentration levels in this volcanic area located in tropical climate. The research was aimed at determining the concentration of pollutants of natural (volcanic) and anthropogenic origin occurring in both lakes. The following parameters were determined: anions, metals, pH and conductivity. Based on the obtained dataset of initial studies it can be stated that the localization of aquatic ecosystems has the significant impact on the chemical composition of surface water.

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1. Introduction

Calderas are important features in all volcanic environments and are commonly the sites of geothermal activity and mineralisation. Descriptions of calderas, based on dominant composition of eruptives (basaltic, peralkaline, andesitic–dacitic, rhyolitic) can be used, and characteristics of each broad group are given. Styles of eruption may be effusive or explosive, with the former dominant in basaltic calderas, and the latter dominant in andesitic–dacitic, rhyolitic and peralkaline calderas [1].The natural lakes have usually been formed by volcanic or tectonic activity. Caldera lakes were formed in the depressions of the collapsed walls of volcanoes. Good examples of caldera lakes are Batur, Bratan, Buyan and Tamblingan lakes in Bali. Crater lakes were formed in the extinct craters. Maninjau and Ranau lakes in Sumatra and Lake Segara Anak in Lombok are typical crater lakes as well as many of the small lakes in Java and Tigawarna Lake in Flores [2].

Bali is one of the Lesser Sunda group of island provinces in the Indonesian archipelago, lying between eight and nine degree south of the equator. Bali covers an area of 563.3 sq. km. Bali landscape is dominated by a chain of volcanic mountain ranges that consist of both active and dormant volcanoes. Bali highest mountain Mount Agung (3143 m) and Mount Batur (1717 m) in eastern Bali are the active volcanoes while Mount Batukau (2276 m) in the centre of Bali and Mount Merbuk (1385 m) in west Bali are the dormant ones. Bali has 18 volcanic peaks exceeding 1000 m above sea level and seven higher than 2000 m above sea level. Because these high peaks are typically cone-shaped, stream pattern is classified as the radial throughout system. Soils are generally andosols and, like in the rest of Bali, originate from very fertile, basic volcanic ejecta. It distinguishes them from the other volcanic regions where soils are sometimes unproductive due to high acidity. The two most prominent landforms of this system are the two massive calderas and four caldera lakes formed during ancient geological disasters. Both calderas have freshwater lake systems, the largest is Lake Batur (17.18 sq. km) in the Mt. Batur caldera. Mt. Sangiyang to the west has three smaller unconnected lakes Danau Buyan, Danau Bratan and Danau Tamblingan [3,4].

Geologically Bali is still active with two main active volcanic centers. A dangerous eruption is expected on average every 30-100 years. The last time both volcanoes erupted in May 1963 and fortunately no one was killed by the eruptions in Batur. Because Bali is situated in a highly active tectonic zone, seismic events are also common. Earthquakes that cause local slight to moderate damage to property occur on average every ten years. Massive earthquakes that cause loss of life are predicted to occur less often than once every 100 years. The most recent event of this nature, which cost hundreds of lives and measured 6.2 on the Richter Scale, was in 1976 [3,4]. Chemistry of the Indonesian equatorial lakes is largely unknown and it is strongly affected by biological and perhaps geothermal processes. This paper is an initial attempt at a regional assessment of different crater lakes chemical composition.

2. Experimental

2.1. Sampling

Water samples from two caldera lakes were collected in February 2013. To avoid losses of analytes to headspace, samplers were filled without a bubble of air. Then samples were transported to the laboratory and stored prior to analysis in the temperature of 4^0C. In order to minimize the storage time the analysis was performed immediately after delivery of the samples to the laboratory. The research area was localized in the Indonesian Archipelago, at the latitude of eight and nine degrees S on the one of the Lesser Sunda group island provinces, Bali (563,3 km^2). Two massive calderas (Mount Batur 1717 m a.s.l.; Mount Sangiyang 2093 m a.s.l.) are one of the most prominent landforms in the chain of volcanic mountain ranges of the Bali Island. Lake Batur (17,18 km^2) and Batur Spring (which are part of the freshwater lake system of Mt. Batur caldera)