Three-dimensional gravity modeling for determining the depth and detailed shape of the volcanic basement rock in the eastern part of Isa municipality, Kagoshima Prefecture

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The municipality of Isa is located in the southern part of Kyushu Island, and it is considered one of the wealthiest places in Japan because one of the most important gold mines is found in this area, Hishikari mine. Alternatively, there are many hydrothermal manifestations, e.g., Hishikari, Yunoo, Kawanami, and Kintaro hot springs, which can be exploited by the community as an electric power source. For this reason, the corresponding researchers conducted a two-layer 3-D gravity modeling in the eastern part of the municipality of Isa, Kagoshima Prefecture, to determine the depth and detailed shape of the volcanic basement rock. This modeling is an essential stage of the complete gravity analysis in the region, because the filtering gravity methods, i.e., Horizontal-Derivative and Tilt-Derivative, can quickly detect steep gradients and indicate the location of faults or geological boundaries, however, they cannot estimate geological structure depth. For carrying out the modeling, an area of 10 x 10 km, which coordinates are 31.97˚N to 32.06˚N and 130.64˚E to 130.75˚E, was selected. According to the Kagoshima geological map, volcanic and sedimentary rocks are the essential type of stones in this area. Cretaceous Shimanto group controls the fundamental structure of the most profound element. This arrangement is typically composed of sandstone, shale, acid tuff with subordinate conglomerates, and their alternations, also Pliocene volcanic rocks and alluvial deposits. Likewise, Kakuto Caldera and Okuchi Basin, which are located at east and west respectively, drive the region. This modeling method requires a contrast in density between the two assumed layers, i.e., the basement and light-density deposit thus a constant density contrast of -0.5 g/cm^3 was assigned, and the horizontal size of cells was 100 m. Furthermore, the reference point was set up at 650 m depth because it gave back the lowest root mean square error. The gravity inversion model shows a significant depression located next to Hishikari hot spring. In this way, the hydrothermal fluids might flow up to the surface forming altered rocks and hot springs by using the geological fault. Alternatively, it shows that the hot spring is either located on the high-density rock or demonstrates the current location of propylitic altered rock. However, the two-layer three-dimensional Gravity Modeling results showed a significant amount of misfit on and around the Hishikari hot spring between 3542500 to 3543500 mN and 659000 to 660500 mE (WGS84/UTM52N), i.e., the gap is around 1.2 mGal. In other words, the RMS evidenced that in the selected area could have an intrusive igneous rock. This consolidated mass, which might have fossilized and cooled down, disturbed the gravity observation. In summarize, the two-layer three-dimensional Gravity Modeling is a decent approach for understanding the geological structures in the Isa area. Nevertheless, this result needs to be corrected by further investigations including inversion modelings.

Keywords: Isa region, gravity data, propylitic alteration, hot springs, two-layer three-dimensional gravity modeling

