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AN ANALYSIS ON SENTINAL DATA FOR MONITORING VOLCANIC ACTIVITY IN AGUNG VOLCANO

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ABSTRACT

The Interferometric Wide (IW) swath mode is the main acquisition mode over land for Sentinel-1. It acquires data with a 250 km swath at 5 m by 20 m spatial resolution (single look). IW mode captures three sub-swaths using Terrain Observation with Progressive Scans SAR (TOPSAR). With the TOPSAR technique, in addition to steering the beam in range as in ScanSAR, the beam is also electronically steered from backward to forward in the azimuth direction for each burst, avoiding scalloping and resulting in homogeneous image quality throughout the swath.

In this study, the underground eruption date of Agung volcano in Bali Island of Indonesia is 21 November 2017, the magmatic eruption date is 25 November 2017. The change in the volcano from 3 different dates is downloaded from ESA and the images are combined and processed in the SNAP program. It was studied. The following is an overview of the operations carried out in this matter. Firstly, images taken for 5, 17 and 29 November 2017 were downloaded from ESA and combined into a SNAP program.

Following a volcanic explosion, the differential interferometry technique was applied to remove the map of the deformation at that site. The interferometric processing chain took several steps, using the trajectory files, to obtain very precise trajectories for each image. In this case, the pixels of the two images were matched exactly the same way. An interferogram is computed by multiplying an image by a complex conjugate. In addition, the topography-dependent phase was removed as the phase was filtered and then geometrically constructed. The data was corrected and then this image was presented using Google Earth.

1. INTRODUCTION

In the scope of this work, the ejection date of the Agung volcano on the Bali Island of Indonesia is 21 November 2017, the magmatic eruption date is 25 November 2017. In this volcano, the GPS image taken on 3 different dates was downloaded from ESA and the SNAP program was used to process the images by combining them. The following is an overview of the operations carried out in this matter. Firstly, images taken between 5 November 2017 and 17 November 2017 were downloaded from ESA and combined into a SNAP program.

2. AGUNG VOLCANO IN INDONESIA

Agung volcano is located in the Bali Island of Indonesia Mount Agung, also known as Gunung Agung, is an active volcano located on the island of Bali in the Indonesia Island arc. It is the highest point on the island of Bali at an elevation of 9944 feet (3031 meters).

Mount Agung is a stratovolcano built by a long history of recurrent eruptions. The stratovolcano has been built up from eruptions that produced andesite lava, volcanic breccia, volcanic ash, and pyroclastic debris. Eruptions at Mount Agung can be deadly and present a variety of volcanic hazards to nearly a million people who live within a 20-mile (30-kilometer) radius of the mountain. The 1963-1964 eruption at Mount Agung was one of the largest volcanic eruptions of the 20th Century, rating VEI 5 on the Volcanic Explosivity Index.

Figure 1. Mount Agung is in orange to symbolise the level three threat and the lava flows.

More recently, in 2017-2018, Mount Agung produced large ash clouds that rose to elevations of about 12,000 feet (4000 meters). These caused an aviation emergency and forced closure of the Ngurah Rai International Airport, ruining the plans of thousands of tourists and other travelers. Fears of pyroclastic flows, lahars and ash falls caused the Indonesian government to order the evacuation of about 100,000 people who live within a 6-mile (10-kilometer) radius of the volcano.

Several volcanic hazards are present at Mount Agung. They are explained below, giving examples from previous eruptions where possible:

- Pyroclastic Flows: During the 1963-1964 eruption an estimated 1700 people were killed by pyroclastic flows. These are superheated clouds of volcanic gas, volcanic ash, and rock debris. The clouds are denser than air, have temperatures as high as 1,830°F (1000°C), and can flow down the slope of a volcano at speeds of over 400 miles per hour (700 kilometers per hour). They destroy and incinerate everything in their path and can flow several miles (kilometers) beyond the base of the volcano before stopping. The only way to survive a pyroclastic flow is to be out of its path before it begins.
- Lahars: After the 1963-1964 eruption, about 200 people were killed by cold lahars [1]. These are mudflows composed of rainwater and volcanic debris from the eruption. Heavy rain falling high on the mountain saturates a thick ground cover of volcanic ash. A landslide, possibly triggered by earthquakes within the volcano, begins and accelerates as it travels downslope, picking up more material and momentum as it travels. The flow might then enter

a stream valley with a velocity that is greater than the water in the stream. The moving mass grows as it sweeps up the stream water. The flow can continue down the stream channel at speeds of over 60 miles per hour (100 kilometers per hour) and travel over 120 miles (200 kilometers) beyond the base of the volcano.

- Mount Agung and Plate Tectonics: The volcanoes of Java, Bali, and many other Indonesian islands have been formed by interactions between the Australia and Sunda tectonic plates. In this area the Australia Plate is moving towards the north-northeast at an average rate of about 70 millimeters per year. The Sunda Plate is moving towards the west-northwest at an average rate of about 21 millimeters per year. These two plates are in collision about 200 miles south of the island of Java to form the Sunda-Java Trench (see Plate Tectonics Map). At the Sunda-Java Trench, the Australia Plate subducts beneath the Sunda Plate and begins its descent into the mantle. The Australia Plate begins to melt when it reaches a depth of about 100 miles. Hot and molten materials then begin rising towards the surface and erupt to form the volcanoes of the Indonesian volcanic arc (see Plate Tectonics Cross-Section).
  The subduction zone is a source of recurrent earthquakes. Many of these earthquakes cluster around the descending Australia Plate. Others accompany molten material rising beneath the volcanoes. Some are associated with deformation of the Sunda Plate and portions of the Australia Plate that have not been subducted. Strong earthquakes near the leading edge of the Sunda Plate can sometimes displace enough seawater to produce a tsunami.

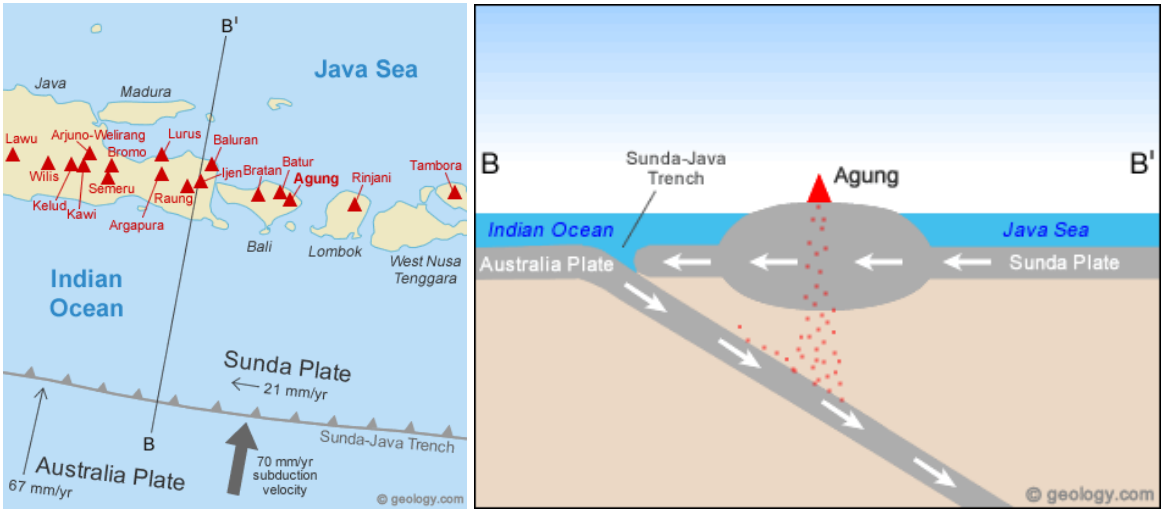

Figure 2. Plate tectonics map for mount agung and mount agung plate tectonics cross section.

3. METHODOLOGY

Agung volcano is located in the Bali Island, one of the most active volcanoes in Indonesia which short eruptions cycle among a few years. Synthetic aperture radar (SAR) is a technique that allows highresolution radar images to be formed from data acquired by sidelooking radar instruments carried by aircraft or spacecraft. The amplitude of a SAR image can be interpreted in terms of the scattering properties of the Earth's surface. For analyzing the deformation events we used Sentinel-1 data derived from Copernicus the Sentinel-1 satellite platform.

3.1 Flow Chart

The high level Sentinel-1 observation strategy during full operations capacity is based on optimum use of SAR duty cycle (25 min/orbit), taking into account the various constraints (e.g. limitation in the number of X-band RF switches, mode transition times, maximum downlink time per orbit and maximum consecutive downlink time). As well known, All SENTINEL-1 SAR data acquired are systematically processed to create predefined product types and are available globally, regionally and locally, within a defined timescale. Here, we ordered by descending Sentinel-1 platform (Product Type: SLC, Polarisation: HH+HV, Sensor Mode: IW)

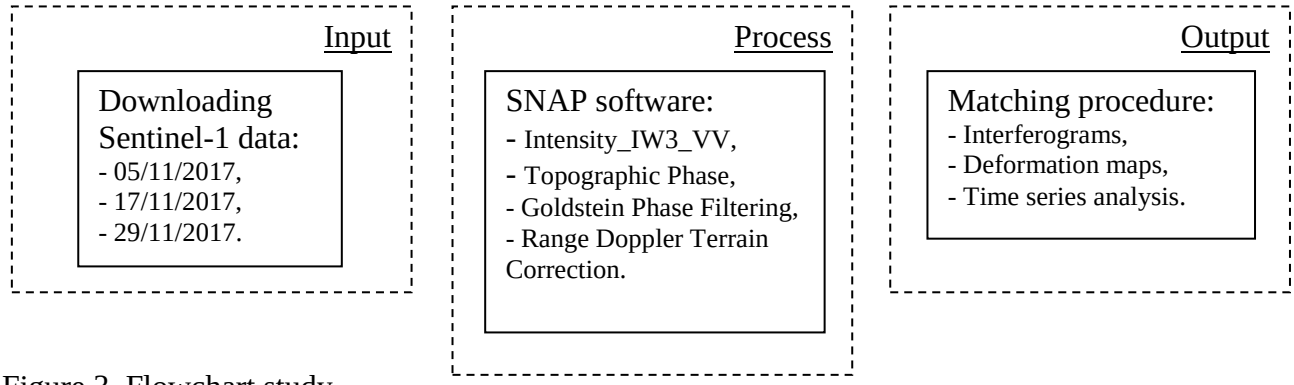

Figure 3. Flowchart study.

4. RESULT AND DISCUSSION

- Differential interferometry was performed to map the deformation in a place caused by a volcanic eruption.
- The interferometric processing chain was carried out a few steps in which the orbit files were applied to obtain very precise trajectories for each image.
- The pixels of the two images are matched exactly to each other.
- Interferograms were calculated by multiplying an image by complex conjugate.
- In addition, the phase bound to the topography was removed because that phase was filtered and then geometrically constructed.
- The data was corrected, and then this image was viewed with Google Earth.

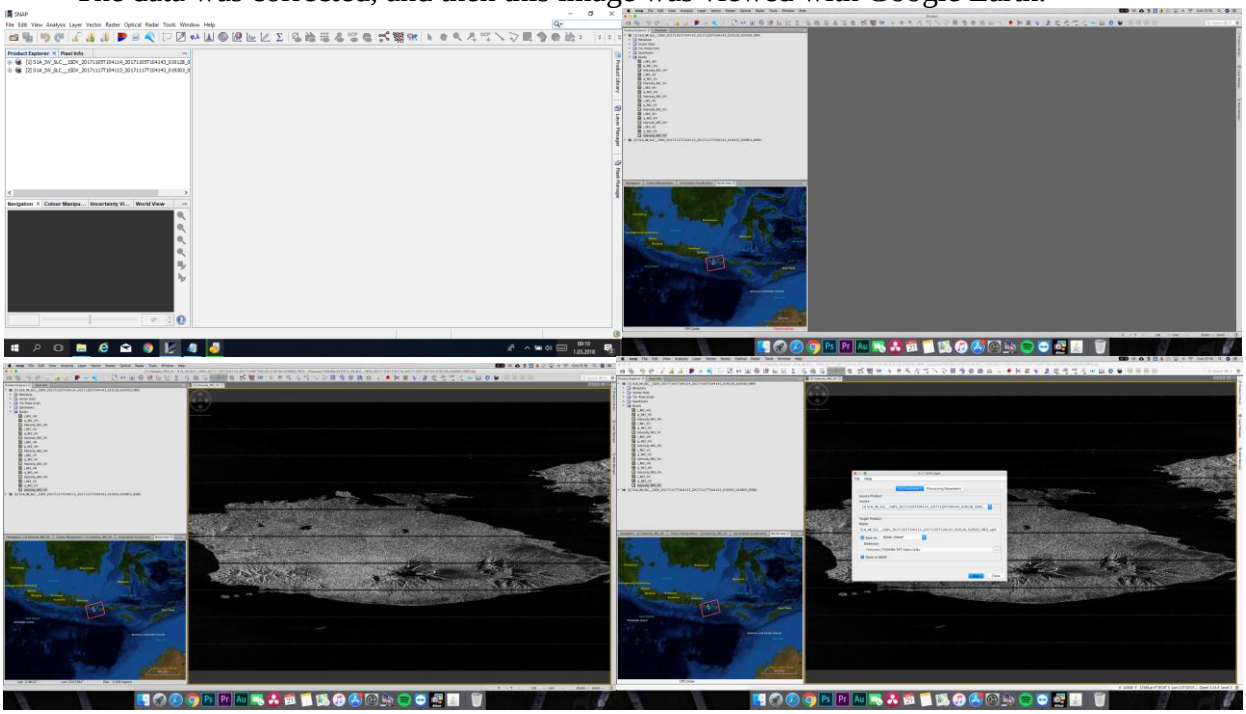

Figure 4. Data downloaded to the SNAP platform, Location of data on the world, A series of eruption within the selected fields, Interface selection of the IW2 image.

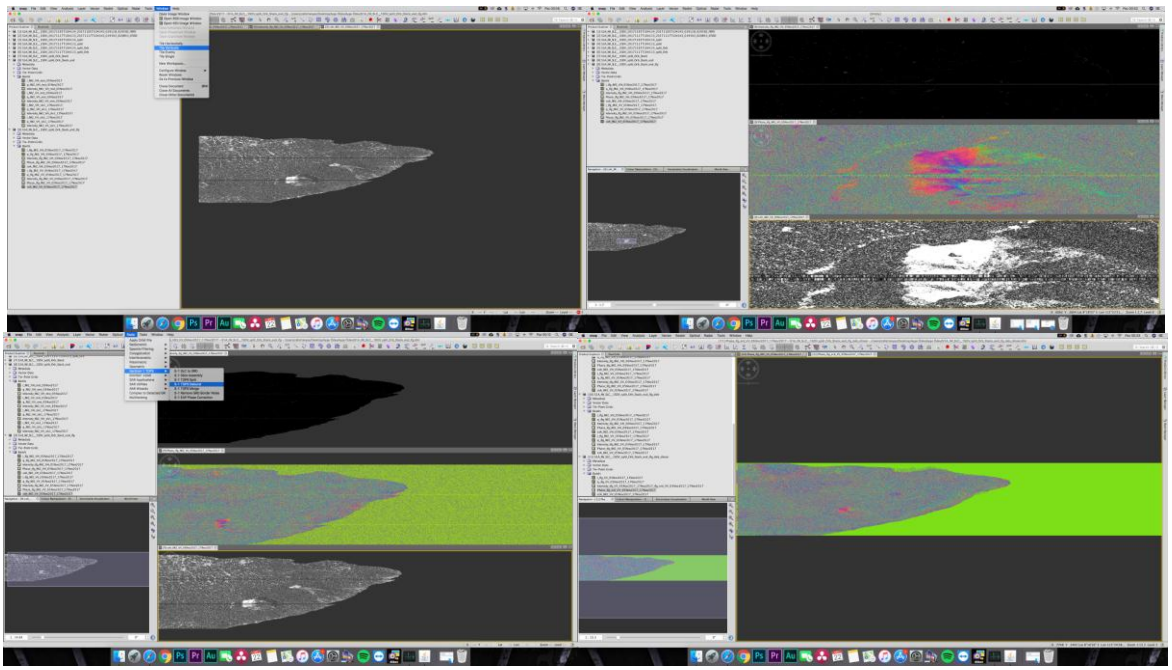

Figure 5. Phase, intensity and coherences in the same screens.

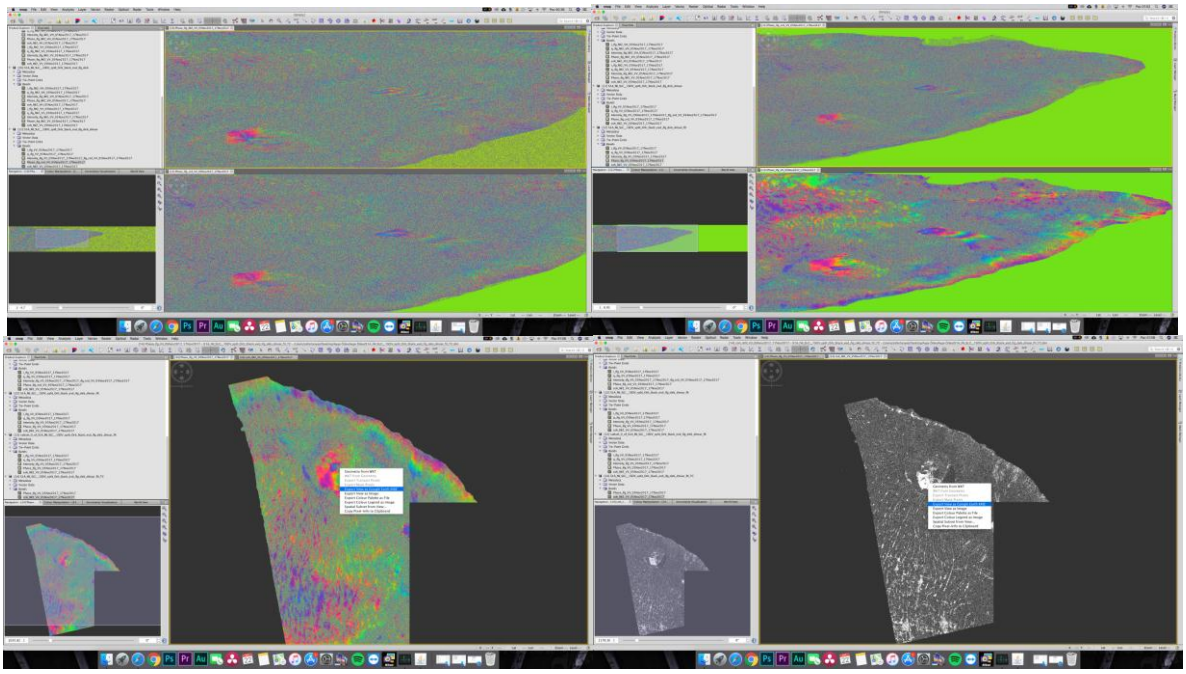

Figure 6. Production steps of phase and coherence.

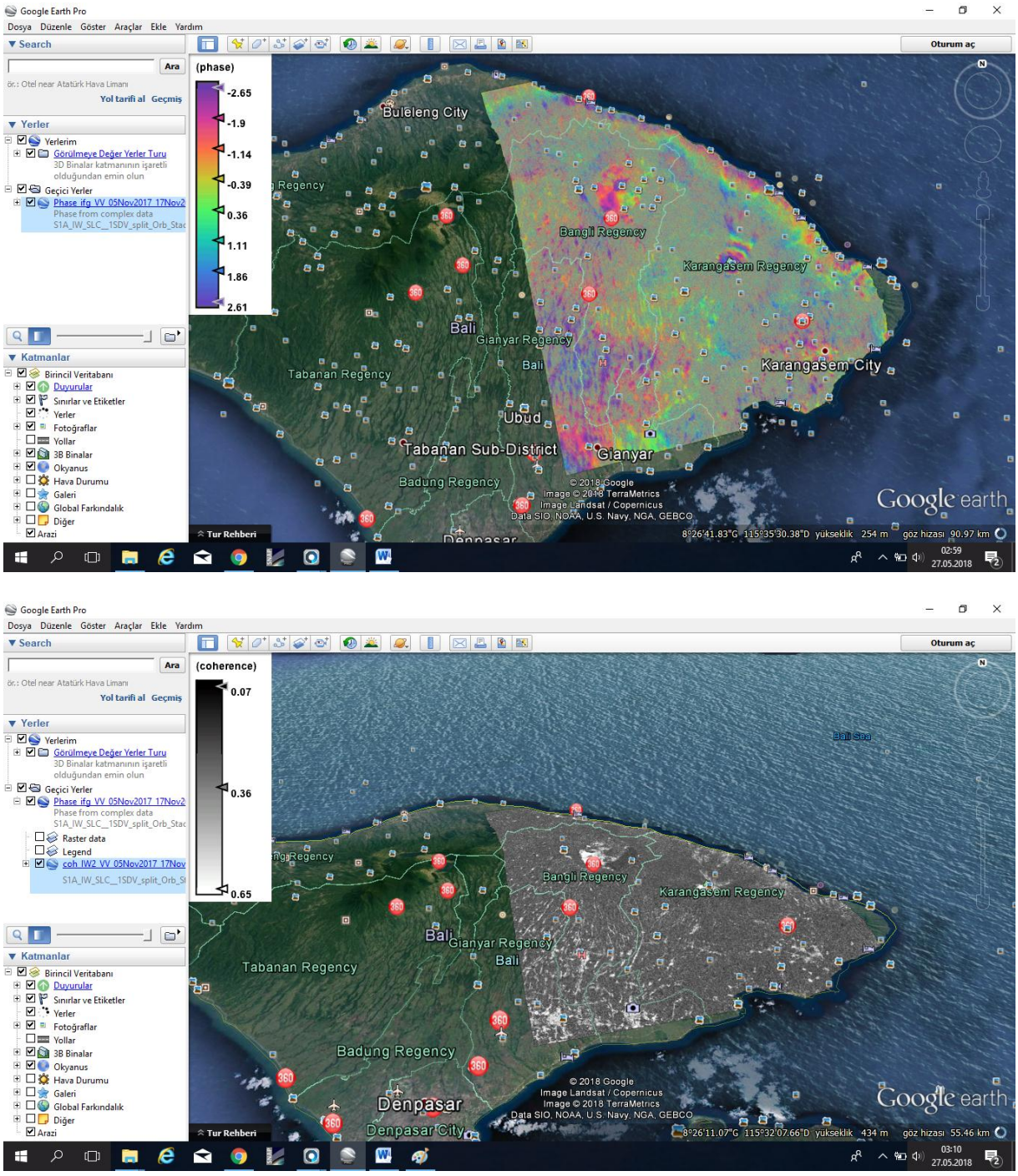

Figure 7. Deformation amounts of volcanic eruption in phase and coherence unit between 05/11/2017 and 17/11/2017.

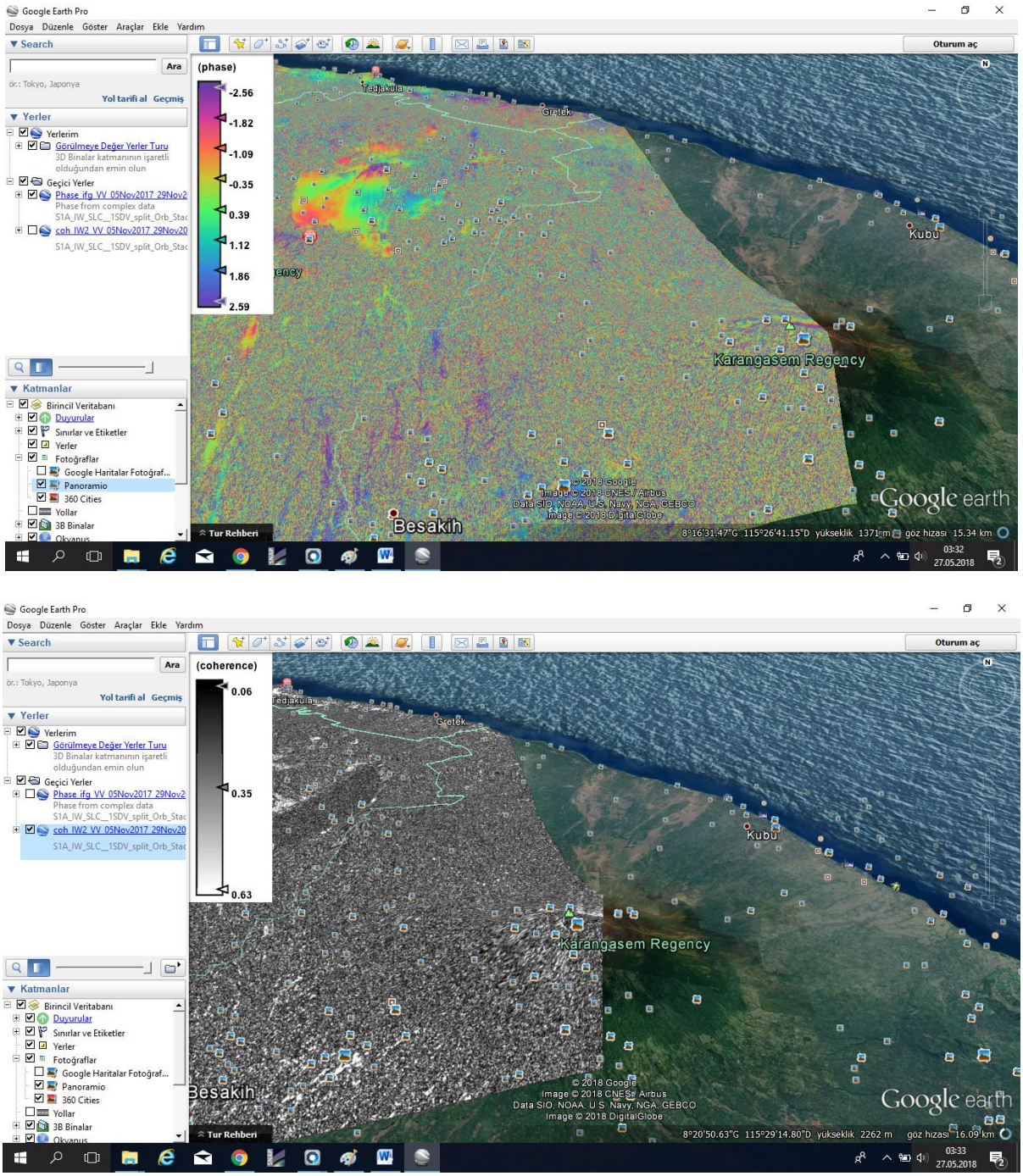

Figure 8. Deformation amounts of volcanic eruption in phase and coherence unit between 17.11.2017 and 29.11.2017.

5. CONCLUSION

In this study, the pits corresponding to the deformation caused by volcanic eruptions were obtained with the help of differential interactions. As a result, the data generated on Google Earth satellite images confirm this. Particularly at this point, there are no intense scattering in other places except the volcano cone. The displacement corresponds to the collapse of the crater following the eruption. In addition, the eaves corresponding to the displacement are generally caused by the lava. Thus, the height of the lava flow increased to positive direction displacement and other places caused negative direction displacement A high compatibility was observed on the parts seen in the

compatibility image and very low compatibility was observed in the other part. A lot of green space was seen compared to the compatible image optical image. The main reason for this is the presence of forest areas where volume scattering will result in loss of compatibility. In other places, there are different types of terrain that can be more stable.

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