PROSPECTS OF VOLCANIC ACTIVITY MONITORING IN THE KURIL ISLANDS

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Part of the “Pacific Rim of Fire”, the 1250-km-long chain of Kurile Islands extends from Kamchatka Peninsula, Russia to Hokkaido Island, Japan. It consists of 68 volcanic centers, among which 36 are considered to be active, i.e. have records of historic eruptive activities. Sixty eruptions were recorded in the Kuriles during the 20th century, among which the most significant were the eruptions of Tiatia, Grozny, Sarychev, Severgin, Raikoke, Ebeko, and Alaid. The most recent examples include the eruption of Chikurachki volcano in April-June 2003 and the eruption of Chirinkotan volcano in July 2004.

The most reliable method of volcano monitoring includes the use of ground-based seismic networks providing real-time data on the seismicity beneath active volcanoes. Unfortunately, there are no permanent seismic networks in the Kuriles. At present, there are only four single component seismic stations in the entire Kurile arc (on the flank of the Alaid volcano, in Kurilsk, Yuzhno-Kurilsk, and Severo-Kurilsk settlements). These stations provide rudimentary seismic data for a few volcanoes, whereas the majority of the active volcanoes are tens to hundreds of kilometers from the nearest station. Installation of the permanent local seismic networks is expensive and feasible only for a few volcanoes which pose a threat to local communities (i.e. Tiatia, Mendeleev, Grozny, Baransky, Chirip, Ebeko, Chikurachki, and Alaid). Remoteness and the lack of communication links will likely preclude the establishment of the regular seismic monitoring (and/or ground observations) for most of the Kuriles for the next few decades.

It appears that remote sensing is the most convenient and cost-effective approach to regular volcano monitoring of the Kuriles. At present, two major sources of the satellite data are used by our group in daily observations: (1) AVHRR data from the NOAA series of polar orbiters and (2) MODIS data from Terra and Aqua satellites. From 1995 to 2000, AVHRR data from NOAA-12 and NOAA-14 satellites have been acquired locally by the Institute of Marine Geology and Geophysics (IMGG) using the “ScanEx” receiving station made by the Research & Development Center ScanEx, Moscow. Although there were a few confirmed small eruptive events during this period of observation the low spatial resolution of AVHRR imagery did not allow their detection. For instance, according to visual observations by on site observers a phreatic eruption of Kudriavy volcano on October 7, 1999 produced a small volcanic ash cloud, which reached an elevation of 1000 meters above sea level. The temperature of a small, hydrothermally heated area at the volcano reached 30°C with the temperatures of emissions from individual fumaroles exceeding 900°C. This activity was not detectable in either the visual, or infrared bands of AVHRR imagery. Meanwhile, the larger scale ash producing eruptive events in the neighboring Kamchatka have been reliably detected.

Since 2001 MODIS data have been acquired by the DalInformGeoCenter of the Ministry of Natural Resources of Russia in Yuzhno-Sakhalinsk using the “UniScan” ground receiving station made by the aforementioned R&DC ScanEx. Compared to AVHRR, MODIS data has significantly improved spectral and spatial resolutions, i.e. 36 channels in visual, NIR and IR spectrums with 250, 500 and 1000 meter resolutions, respectively. Since the launch of Aqua satellite in 2002, we have been able to acquire two swaths daily for the Kuriles. The entire station mask covers the area from the Arctic regions to Taiwan Island and from the Anadyr Bay to the Western Siberia. In 2003, the DalInformGeoCenter resumed the acquisition of NOAA AVHRR data. At present, more than twenty two swaths are received daily for the Kuriles from NOAA-12, 14, 15, 16, and 17 satellites. Our monitoring capabilities will improve following the anticipated upgrade of the receiving station by summer 2004, which will allow acquisition of
MSU-E and MSU-SK data from the Meteor-3M satellite with 35-m and 250-m ground resolutions respectively.

Beginning in January 2003, our Sakhalin-based group of scientists from IMGG and DalInformGeoCenter has performed satellite observations of the Kurile Islands on a regular basis. The high spatial resolution of MODIS imagery complemented by the high temporal resolution of AVHRR data allowed us to observe the 2003 Chikurachki eruption as well as the manifestations of moderate volcanic activity, i.e. steam plumes at Sinarka and Severgin volcanoes, mud flows from Tiatia volcano, and most recently the gas and ash plume at Chirinkotan volcano. Because of a high volume of the original data, it is first processed at the receiving stations of DalInformGeoCenter, which includes (1) acquisition of the raw data from satellites, pre-processing and calibrating, (2) georeferencing the data, (3) extracting the sub sectors covering the Kuriles, and (4) converting data to BMP and JPEG formats. This allows us to reduce the MODIS data to three files totaling 5 Mb in size. As soon as processing is completed, these images are sent via email to the Volcanological Laboratory of the IMGG, where they can be interpreted by volcanologists.