

Evidence of recent hydrothermal activity in the Amami caldera: discovery of Fe-Mn oxide crusts enriched in As and Mo

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In the south of the Tokara Islands, only one volcano, Iou-Tori Shima, is stand above the sea surface, but many submarine cones are identifiable in the seafloor. To confirm the geological characteristic of the cones, whether volcanic or tectonic in origin, dredge survey were carried out during Nagasaki-maru cruises (NAG 267, NAG274) and Tansei-maru cruise (KT0015) and compared with the dredged samples and subaerial samples from Yokoate Shima and Iou-Tori Shima.

The dredge sampling on the ten submarine cones in the south of Yokoate Shima on the Tokara volcanic ridge were carried out. Nine out of ten submarine cones were successfully recovered rock samples, which are variably vesiculated acidic rocks. In contrast to the subaerial rock samples, andesitic rocks were not recovered from seafloor. Therefore basic to intermediate volcanic rocks occur only in the subaerial part of Iou-Tori shima.

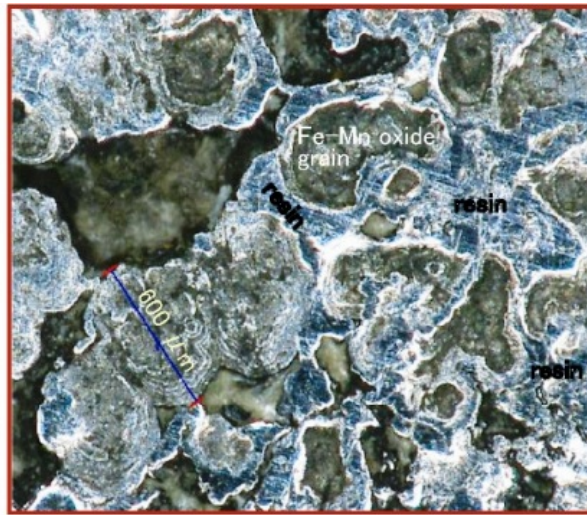
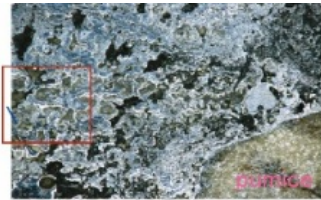
The rhyolitic rocks dredged from the seafloor are plotted on the extrapolation area of the geochemical trends of subaerial volcanic rocks from Yokoate Shima and Iou-Tori Shima. This implies that they were derived from similar magmatic processes. The dredged samples are systematically depleted in K₂O compared with those in the northern Tokara volcanic ridge (Yokose et al., 2008). Many dredged pumices were occurred on the steep submarine flanks of the volcanic cones. In some dredge station, the chemical compositions of the pumices are identical, but the variation in the vesicularity is quite large. These occurrences may suggest that the pumicious rocks could be originated by a peripheral face of the lava dome, which were relatively enriched in the volatile components, rather than a plinian eruption at subaerial condition.

Ten few kg of Fe-Mn oxide crusts were recovered from the bottom of Amami caldera and were accompanied with variably vesiculated rhyolitic rocks. The Fe-Mn oxide crusts are weakly consolidated and classified into two types, black and reddish amber types. The global black grains are loosely packed and have a concentric layered structures observed under a microscope (see figs). In the case of the reddish amber type Fe-Mn crust does not indicate such mineralogical texture.

Representative Fe-Mn crusts, both black and reddish amber types, are analyzed whole rock chemical compositions (see table). Approximately half of the Fe-Mn crusts, black and reddish amber types, comprise of MnO and Fe₂O₃ respectively. In the trace element compositions, both samples are enriched in As (~3000 ppm), Mo (800~400 ppm), Ba (1000 ppm). On the other hand, the concentrations of S, Co, Ni, Cu, La in the Fe-Mn oxide crust are not so high. The abundance of Fe, Mn, Co, Ni, Cu in the Fe-Mn oxide crusts are differ from those in a pelagic manganese nodule and indicates that these Fe-Mn oxide crusts were originated from the hydrothermal activity. Because the black type Fe-Mn oxide crust includes fresh pumicious breccia, the hydrothermal activity was established simultaneously with the lava dome formation or the latter cooling stage. As the Fe-Mn oxide crusts are poor in sulfur, high temperature hydrothermal activity with ore formation under the seafloor is unknown, but, at least, similar hydrothermal activities along the current volcanic front may be tracked continuously from the southern Kyushu to the central Ryukyu arc.

Based on the above observations, the distribution density of the active volcanoes in the central Ryukyu arc could be identical to the those in the southern Kyushu. Especially, volcanic cones located in the south of Yokoate Shima are characterized by acidic volcanism. Some of the volcanic cones probably have hydrothermal activities on the seafloor likewise Amami caldera, but didn't discover yet.

Yokose et al. (2008a) Submarine calderas in the Tokara Islands 1: Geochemical characteristics of lavas from the Tokara Islands. JPGU 2008 meeting abstract, J164-P008.



sample	Lava dome aphyric rhyolite	Is (n=7) ±σ	6-22B Black	6-22C Reddish black
SiO ₂	76.18	0.28	19.71	20.13
TiO ₂	0.22	0.02	0.10	0.04
Al ₂ O ₃	12.62	0.11	3.78	0.63
Fe ₂ O ₃	2.03	0.16	20.67	58.80
MnO	0.06	< 0.01	45.55	12.05
MgO	0.32	0.02	3.70	2.29
CaO	1.87	0.17	2.64	2.12
Na ₂ O	4.35	0.06	1.41	1.03
K ₂ O	1.94	0.13	1.67	0.74
P ₂ O ₅	0.03	< 0.01	0.79	2.17
total	99.59		100*	100*
S (ppm)	n.d.		635	324
Cl (ppm)	n.d.		3400	407
Co (ppm)	1.2		10	40
Ni (ppm)	<1		70	30
Cu (ppm)	6.10		39	39
Mo (ppm)	1.3		834	417
As (ppm)	10.20		3082	3076
Sr (ppm)	n.d.		560	613
Ba (ppm)	n.d.		1075	1008
La (ppm)	13.14		19	5

n. d. = not determined; * normalized to 100%