# Annual Report FY 1997

# 平成９年度 活動報告


## Institute for Geothermal Sciences

Graduate School of Science
Kyoto University

京都大学
大学院理学研究科

## 附属地球熱学研究施設

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# Graduate School of Science, Kyoto University

# 京都大学大学院理学研究科
# 附属地球熱学研究施設


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Front Cover Image:
The strombolian explosion in the 1st crater of Mt.Nakadake, Aso volcano in October 1979.
(Photograph: M.Sako)

表紙の写真：
１９７９年１０月の阿蘇中岳第１火口のストロンボリ式噴火の様子
（迫幹雄撮影）


Editorial compilation by T. Hashimoto and Y. Furukawa
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# Preface

It is my great pleasure to publish the first issue of the annual report from the Institute for Geothermal Sciences, Graduate School of Science, Kyoto University, which was established in April 1997, by unifying the Beppu Geophysical Research Laboratory (BGRL; established in 1924 at Beppu) and the Aso Volcanological Laboratory (AVL; established in 1928 at Aso), for the purpose of comprehensive studies of thermal phenomena in the Earth's interior. As the preface of this first annual report, I would like to introduce the basic concept for and the progress of establishment of the new institute.

Various phenomena occurring on the Earth's surface, such as tectonic evolution, earthquake, volcanism and hydrothermal activity have been caused essentially by heat transfer from the Earth's core, *via* mantle, to its surface. Instead of the common heat source for such surface phenomena, highly specific skills have been applied for studying those phenomena, probably because their variable time/space scales. This was true for two laboratories, AVL and BGRL. The AVL had conducted studies mainly on volcanic activity, including prediction of volcanic eruption, based on seismology, geodesy and geoelectromagnetism etc., and the BGRL had done studies mainly on subsurface flow and circulation of geothermal fluids based on hydrology, hydrodynamics and geochemistry etc.

The final goal of earth sciences is not only to elucidate individual phenomena, but also to understand comprehensively the characteristics and the evolution of the Earth including the prophecy. In order to achieve this, it is indispensable to conduct a comprehensive study of the Earth as a Heat Engine by unifying hitherto subdivided branches and skills. We may further emphasize that the comprehensive study on the Earth should provide deep insights into individual phenomena occurring on the Earth.

In the summer of 1992, when Professor Emeritus Ichiro Nakagawa was holding the positions for director both of BGRL and AVL, the plan of unifying two laboratories was first discussed as one of the foregoing plans. It was the time when Japanese universities began to go forward the way of renewing their organizations such as repletion of the graduate schools. Extensive discussions for realizing the plan started at the beginning of 1994 and led to the first draft of "The plan to unify and reorganize BGRL and AVL", in which the name, "Institute for Geothermal Sciences," was first proposed. This plan was listed up in the budget for the 1996 fiscal year of Kyoto University, and presented to the Ministry of Education, Culture and Sports (Monbusho).

In 1996, the plan was investigated in full detail by Kyoto University and Monbusho in order to prepare the final plan for getting advice from the Committee Exterior organized by intelligent persons outside of Kyoto University. Through the progress, the new Institute was finally established on 1 April 1997. The Institute was attached initially to Faculty of Science and has belonged to Graduate School of Science since April 1998.

The Institute has two main buildings at Beppu and Aso, which had been used as BGRL and AVL, respectively. Although both buildings were rather old, they had been renewed almost all-out before the start of the new Institute.

Here, I would like to express my cordial gratitude to the persons in organizations concerned, who made great efforts to establish the Institute and to renew the buildings.

We had also big changes in personnel affairs in 1997. Just the day before the start of the new

Institute, Professor Yoshimasa Kobayashi (Aso), who made great contributions to this renovation, retired. In August 1997, Professor Yoshiyuki Tatsumi arrived at Beppu from Faculty of Integrated Human Studies, Kyoto University. In March 1998, Assistant Professor Shigetomo Kikuchi (Aso), Technician Toshihiro Yamada (Aso) and Technical Assistant Natsuko Oda (Beppu) were left from the Institute. On 1 April 1998, Associate Professor Yoshitsugu Furukawa arrived at Beppu from Division of Earth and Planetary Sciences, Kyoto University, and Dr. Tatsuhiko Kawamoto was adopted as the Assistant Professor at Beppu.

Thus, renovation of the institutional organizations has been completed and disposition of staffs is now being fixed up. However, it is left to our activities wholly in the future how to replenish our Institute and how to develop "the comprehensive studies of thermal phenomena within the Earth". I wish that this annual report will be put to practical use for mutual understandings among staffs and daily activities in study. At the end of the preface, I would like to entreat all people to understand our activities and to look for guidance to further development of the Institute.

Beppu, May 1998

Yuki Yusa, Professor/Director

# 序

平成９（1997）年４月、それまでの地球物理学研究施設（大分県別府市：大正13（1924）年設立）と火山研究施設（熊本県阿蘇郡長陽村：昭和３（1928）年設立）が改組・統合され、「地殻表層からマントルに至る熱構造・熱現象の研究と教育」を目的として、地球熱学研究施設が発足しました。それから１年余が経過し、施設の皆様のご努力とご協力によって、ここに最初の活動報告を発行できることは大きな喜びです。

この活動報告を発行するに当たり、本施設が発足するに至った理念と経過を記しておきたいと思います。

地殻変動・地震・火山活動・地熱温泉活動など地球表層で起こる現象は、地球内部の熱源に起因する同根の現象です。それにもかかわらず、これまでは、これらの現象の時間スケールや発現様式の違い、あるいは実生活との関連を重視するあまり、それぞれを独立した現象として取り扱うのが一般的で、研究分野も研究手段も細分化の方向に進んできました。

別府と阿蘇の施設は、創設以来、いずれも地球表層の熱現象を研究の対象としてきたことでは、共通の基盤に立っていましたが、研究の方向は異なっていました。阿蘇では、火山噴火現象の解明さらには噴火予知を主目的として、地震学・測地学・地球電磁気学などの手法を用いた研究が行われてきたのに対し、別府では、地下に存在する地熱流体の性状や流動・循環を対象として、陸水物理学・流体力学・地球化学などの手法を用いた研究が行われてきました。しかしながら、そうして得られた成果は、互いに密接に関連している現象のある一面に対する描象である、と考えるべきでしょう。

地球科学が目指すものは、個々の現象の解明だけでなく、それらを通して、地球の特性さらには進化を、予言性をも含めて包括的に理解しようとするところにあります。そのためには、これまでの細分化された研究分野と研究手法を融合し、地球を一つの熱機関とみなして、総合的に研究することが必要不可欠であるのは言うまでもないことです。逆に、そのような総合化によってこそ、個々の現象に対する理解も深められるに違いありません。

以上のような理念を下地にして、２つの施設を統合・改組する構想がはじめて話題に上ったのは、中川一郎先生が両施設の施設長を兼ねておられた、平成４年の夏だったと記憶します。ちょうど、全国の大学が大学院重点化を始めとする組織改革への道を歩みだした頃に当たり、私たちの構想も、この時代の趨勢と無縁ではなかったと思います。

この構想の実現のため、機会あるごとに議論が重ねられ、平成６年に年があらたまってすぐ具体的な作業が始まり、５月には「地球物理学研究施設・火山研究施設の統合及び部門の改組・転換計画（第一次検討案）」が得られ、同年９月13日に開催された両施設の教官会議で、その大筋が承認されました。「地球熱学研究施設」という名称は、この一次案で提案されたものです。この間も、また、その後も、理学部事務局と打合せが続けられ、平成８年度概算要求に将来構想として、この計画が盛り込まれました。さらに、平成７年度と８年度の２年間を費やして、大学事務局・理学部そして文部省で詳細に検討され、また、京都大学外の識者から成る外部評価委員会からご助言をいただきながら、成案としてまとめあげられて、平成９年４月１日付けで新施設が発足する運びになりました。また、発足当初は理学部附属でしたが、平成10年４月には大学院理学研究科附属に移行しました。

新施設の前身である別府と阿蘇の施設の本館建物は、いずれも創設時に建設されたもので、内

壁のはく落・窓枠の破損・各所での雨漏りなど、老朽化が著しかったのですが、新施設の発足に先だって、平成６年度には阿蘇の、平成７年度には別府の建物が全面的に改修され、研究環境が一新されたことも、付言しておきたいと思います。

新施設の実現と建物の改修に対して払われた、関係諸機関と担当者の並大抵ではないご尽力に、深く感謝の念を捧げる次第です。

平成９年度は、人事面でも大きな変化がありました。新施設発足の前日、この計画の立案と実現に多大の貢献をされた小林芳正教授（阿蘇）が退官されましたが、８月には巽好幸教授が総合人間学部から配置換により着任（別府）されました。そして、１０年３月末日をもって、菊池茂智助手（阿蘇）と山田年廣技官（阿蘇）が退官され、小田奈津子技術補佐員（別府）が退職されました。続いてその翌日、平成10年４月１日付けで、古川善紹助教授が地質学鉱物学教室助手から昇任（別府）、川本竜彦助手が新規採用（別府）されました。

以上のように、制度としての組織の改革は完成し、人員構成も整いつつあります。施設を今後どのように充実させ、施設の理念である「地球熱現象の総合的解析」をどのように発展させていくかは、一に私たち構成員の活動如何にゆだねられています。この活動報告が、相互理解と研鑽のよすがとして、活用されることを願います。そして、施設外の方々には、私たちの活動に対するご理解をいただくとともに、施設の発展に向けてご指導をたまわりますよう、お願い申し上げます。

平成10年５月
地球熱学研究施設長
由佐　悠紀

# 構　成　員　Members

## 教　　授　*Professors*

巽　好幸　Yoshiyuki Tatsumi
由佐悠紀　Yuki Yusa（施設長　**Director**）

## 助 教 授　*Associate Professors*

北岡豪一　Koichi Kitaoka
須藤靖明　Yasuaki Sudo
田中良和　Yoshikazu Tanaka

## 助　　手　*Assistant Professors*

橋本武志　Takeshi Hashimoto
菊池茂智　Shigetomo Kikuchi
平成１０年３月　定年退職
大沢信二　Shinji Ohsawa
小野博尉　Hiroyasu Ono
筒井智樹　Tomoki Tsutsui

## 外国人研究員　*Visiting Scientist*

Milton A. Garces

## 技　　官　*Technical Professionals*

外　輝明　Teruaki Hoka
増田秀晴　Hideharu Masuda
馬渡秀夫　Hideo Mawatari
迫　幹雄　Mikio Sako
山田年廣　Toshihiro Yamada
平成１０年３月退職
吉川　慎　Shin Yoshikawa

## 技能補佐員　*Office Manager*

森　忠敬　Tadataka Mori

## 事務補佐員　*Secretaries*

福田きよか　Kiyoka Fukuda
今村町子　Machiko Imamura
中野ちはる　Chiharu Nakano

## 技術補佐員　*Technical Assistant*

小田奈津子　Natsuko Oda
平成１０年３月退職

## 臨時用務員　*Temporal Assistant*

山崎咲代　Sakiyo Yamasaki

## 非常勤研究員　*Research Associates*

川本竜彦　Tatsuhiko Kawamoto
平成１０年３月　退職
中村　衛　Mamoru Nakamura
琉球大学理学部へ異動

## 大学院生　*Graduate Students*

網田和宏　Kazuhiro Amita　D1
森　健彦　Takehiko Mori　D2
中坊　真　Makoto Nakaboh　D1
大羽成征　Shigeyuki Oba　M2
平成１０年３月　卒業
大上和敏　Kazutoshi Oue　D2
田中麻貴　Maki Tanaka　M2
平成１０年３月　卒業

## 研 修 生　*JICA Guest Researcher*

Gabriel Lopez Colmenares（メキシコ）
JICA研修生
（1997年7月14日～9月12日）

# 研 究 活 動　Research Activities

## 研究報告　Scientific Reports

**Resistivity structure of Aso volcano**

***Amita, K., Hashimoto T., Masuda, H., Mori, T., Nakaboh, M.,***
*Yamamoto, M., Kawakatu, H., Ide,S., Kaneshima, S. and Ohminato,T.*

Kaneshima et al. (1996) inferred a water-bearing layer at the depth of 1 to 1.5km beneath the active crater of Aso from broadband seismic observation since 1994. They speculated that the aquifer is continually resonating with a dominant period of 15 seconds as a result of interaction between ground water and heat from magma. We are going to detect the aquifer as a pattern of contrast in the electrical conductivity by means of electromagnetic method. On November 1997, ULF, ELF, VLF and broadband magnetotelluric surveys were performed around Mt. Nakadake, Aso volcano, Japan, for getting resistivity structure beneath the crater. An apparent resistivity curve obtained using a broadband equipment has following features as shown in Fig. 1. (1) Apparent resistivity values over the full range of periods are lower than several hundred ohm-m. (2) Minimal apparent resistivity is close to 10 ohm-m around 1 Hz. Although error-bars are rather small in Fig. 1, it is obvious that the frequency band around 0.1- 0.3 Hz is distorted by artificial noise and the sounding curves of this band is somewhat shifted. We must eliminate the noise by the remote-reference process in order to get precise resistivity structure by an inversion.

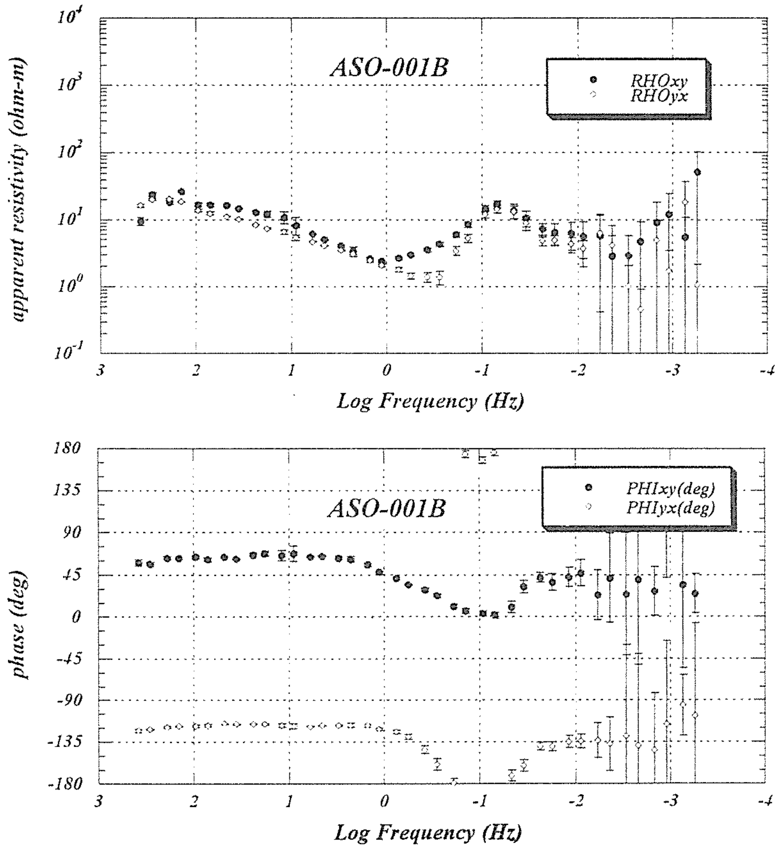



Fig.1 An example of sounding curves obtained by the broadband-MT measurements nearby an active crater of Aso volcano. Upper panel shows the apparent resistivity and the lower the phase.

## Magma acoustics and time-varying melt properties at Arenal Volcano, Costa Rica

*Garces, M.A., Hagerty, M.T. and Schwartz, S.Y.*

Acoustic and seismic signals recorded simultaneously during the Strombolian activity of Arenal Volcano provide conclusive evidence that pressure waves are generated and propagated within the magma-gas mixture inside volcanic conduits. These pressure waves are sensitive to the flow velocity and to small changes in the gas content of the magma-gas mixture, and thus can provide useful indicators of the time-varying properties of the unsteady flow regime and the chemical composition of the melt. Steady fluid flow cannot generate seismic and acoustic signals, thus the fact that we observe these signals implies that unsteady processes are quite prominent during volcanic eruptions. The dominant features of the observed explosion and tremor signals at Arenal are attributed to the source excitation functions and the acoustic resonance of a magma-gas mixture inside the volcanic conduit. We postulate that explosions are triggered in the shallow parts of the magma conduit, where a drastic pressure drop with depth provides a region where violent degassing can occur. Tremor may be sustained by unsteady flow fluctuations at depth. Equilibrium degassing of the melt creates a stable, stratified magma column where the void fraction increases with decreasing depth. Disruption of this equilibrium stratification is thought to be responsible for observed variations in the seismic efficiency of explosions and enhanced acoustic transmission from the interior of the conduit to the atmosphere.

## Travel times for infrasonic waves propagating in a stratified atmosphere

*Garces, M.A., Hansen, R.A. and Lindquist, K.G.*

The tau-p method of Buland and Chapman (1983) is reformulated for sound waves propagating in a stratified atmosphere under the influence of a height dependent wind velocity profile. For a given launch angle along a specified azimuth, the ray parameter is redefined to include the influence of the horizontal wind component along the direction of wave propagation. Under the assumption of negligible horizontal wind shear, the horizontal wind component transverse to the ray propagation does not affect the direction of the wave normal, but displaces the reference frame of the moving wavefront, thus altering the observed incidence azimuth. Expressions are derived for the time, horizontal range, and transverse range of the arriving waves as a function of ray parameter. Algorithms for the location of infrasonic wave sources using the modified tau-p formulation in conjunction with regional atmospheric wind and temperature data are discussed.

**Hydrothermal and ground water system of Sakurajima volcano**

*Hashimoto, T., Tanaka, Y., Mogi, T. and Oba, S.*

A banded self-potential (SP) anomaly was found in the western part of Sakurajima volcano, southwestern Japan. This positive SP anomaly lies along the fissure of 1914 eruption and probably corresponds to the upflow part of subsurface hydrothermal convection. A DC electric resistivity sounding conducted along the survey line across the banded anomaly revealed that a conductive part exists 50-100m below the positive SP zone (Fig. 3). These results suggest that the hydrothermal fluid flow is more prominent in the fractured zone adjacent to a vent than in the vent itself choked with the solidified lava.

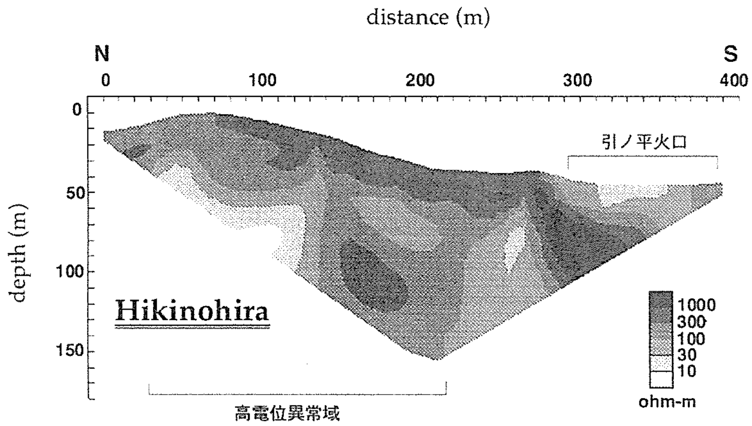



Fig. 3. A resistivity cross-section across the banded SP anomaly obtained by two dimensional DC electric sounding inversion (Uchida, 1993). The positive SP anomaly corresponds to the low resistivity part.

## Melting Temperature and Partial Melt Chemistry of Hydrous Upper Mantle

*Kawamoto, T*, Holloway, J. R. (Tempe, USA), Rubie, D. C. (Bayreuth, Germany)

A series of high pressure and temperature experiments on hydrous mantle peridotites were conducted to determine the $H_2O$-saturated solidus. The solidus of $H_2O$-undersaturated mantle peridotite have been calculated based on (1) the $H_2O$-saturated solidus, (2) the pressure dependence of hydrogen solubility in nominally anhydrous minerals, and (3) the assumption of linearity between $H_2O$-undersaturated solidus and $H_2O$ abundance at a given pressure (Figure 1). Previous studies of melt inclusions suggested that mid oceanic ridge basalts, Hawaiian hot spots basalts, and Archean komatiites can be produced through partial melting of 100 - 200, 250 - 450, and 600 - 1800 ppm $H_2O$ bearing mantle peridotites, respectively. If those hydrous mantle peridotites follow the present mantle adiabat underneath mid oceanic ridges, then the partial melting should start at depths equivalent to 2.5 GPa beneath mid oceanic ridges, 3.5 GPa under Hawaiian hot spots, and 5.5 - 14 GPa to form komatiites, respectively.

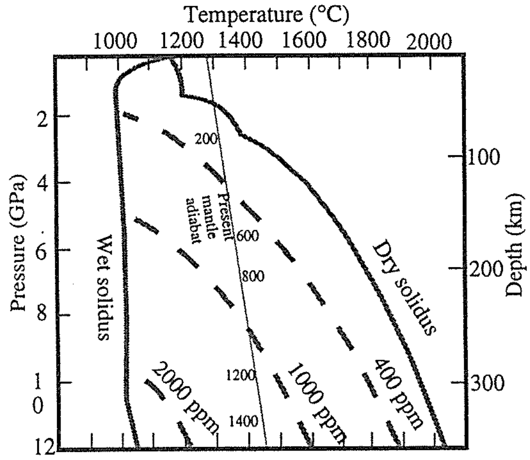



Figure 1 Calculated melting temperature of $H_2O$-undersaturated mantle peridotite ($H_2O$ abundance in ppm). The numbers along the present mantle adiabat indicate ppm $H_2O$ concentrations of mantle peridotite which can start melting at the pressure.

# Continuous Observation of Ground Deformation Using Water Tube Tiltmeters and Extensometers in Underground Tunnel near Naka-dake

*Kikuchi, S.*

The tunnel for ground deformation observation located in 30m underground at about 1km south-west of Naka-dake crater and consists of horizontal tunnels forming equilateral right-angled triangle. The remarkable ground deformation in 1997 was not detected on the records observed in the underground tunnel near Naka-dsake.

Watertube tiltmeters of 25m span (WT1 and WT2) and Extensometers of 20m span (E1 and E2, Fig.1) and 25m span (E3) have been installed in the tunnel.

Extensometers recorded annual variation with strain amplitude of $10^{-6}$ order that is contraction in summer season and expansion in winter season

Watertube tiltmeter showed about 4 $\mu$ rad tilt northward (crater side) which continued from the previous year. This tilt is compatible with the quietness of crater.

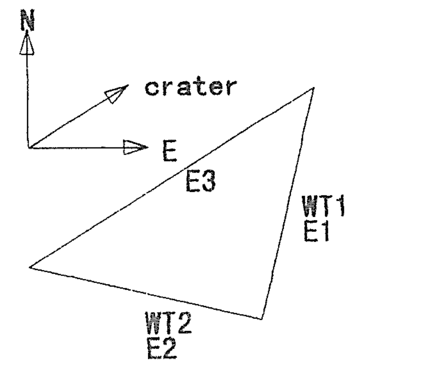



Figure 1. Tunnel and setting of watertube tiltmeters (WT1,WT2) and extesometers (E1,E2,E3).

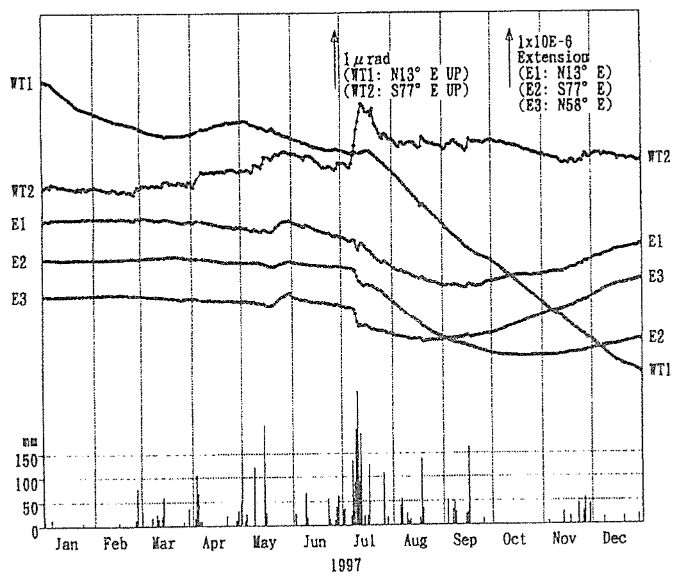



Figure 2. Ground deformation records in 1997. Lower is daily precipitation.

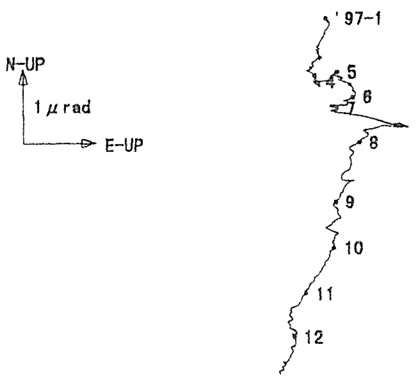


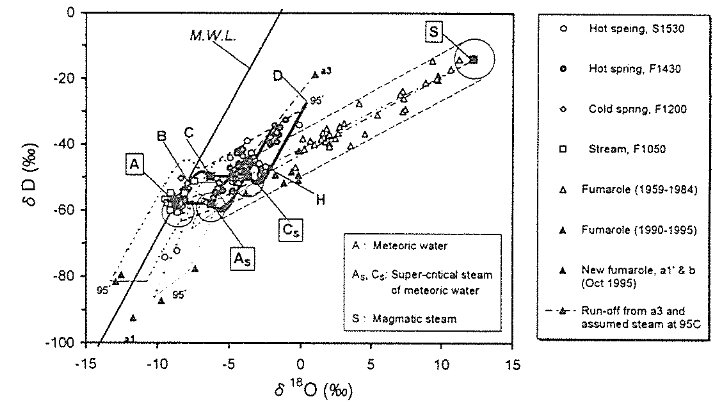

Figure 3. Upward vector from watertube tiltmeter observation. Attached numbers show months(1st day).

## Isotopic study on interaction between magmatic fluid and meteoric water at Kuju-Iwoyama Volcano, Kyushu, Japan

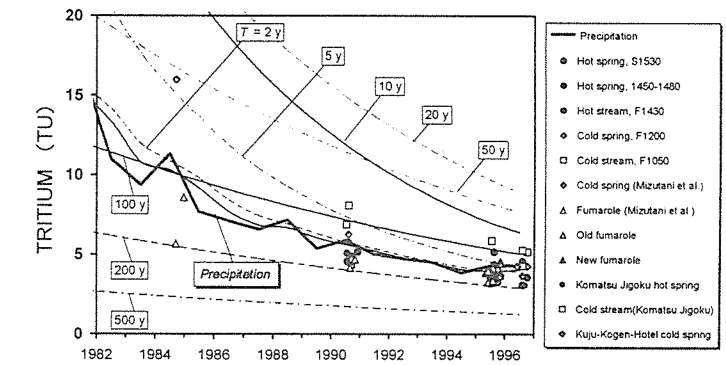
*Kitaoka, K., Ohsawa, S., Yusa, Y. and Kusakabe, M.*

Magmatic fluids have to pass through meteoric water circulation systems to flow out from the inside of the earth. The interaction between magmatic fluids and meteoric waters is highly complex. Significant subsurface boiling of the deep circulating geothermal waters in Kuju-Iwoyama Volcano, Kyushu, was demonstrated by the hydrogen and oxygen isotopic study of hot spring waters and fumarolic steam condensates. Part of meteoric water is heated to the critical point of water during a hydrologic cycle through the volcano, forming a single-phase steam. The linear $\delta D$-$\delta^{18}O$, $\delta D$-Cl, and $\delta^{18}O$-Cl relationships for fumarolic condensates appear to have resulted from mixing at depths of the volcano between a magmatic steam and the super-critical steam of meteoric water origin.

Remarkable difference of residence time between two-phase and liquid water systems was revealed through the tritium study of hot spring waters and fumarolic condensates. Very short residence times within about 5 years of meteoric water in the single-steam and two-phase systems were estimated, whereas long times over about 100 years in the deep circulating liquid water system were estimated in the volcano. This means that the main water movement in the volcano is caused by steam brewing.




Oxygen-18 and deuterium relations observed for hot spring waters,cold spring waters, and fumarolic condensates. Open triangles of fumarolic condensates are quoted from litarature.

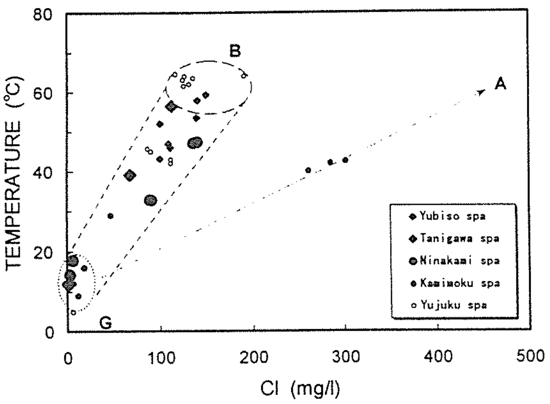



Tritium data for hot spring waters, cold spring waters, stream waters and fumarolic condensates. Curves are output from exponential model by the input of precipitation indicated by bold line.

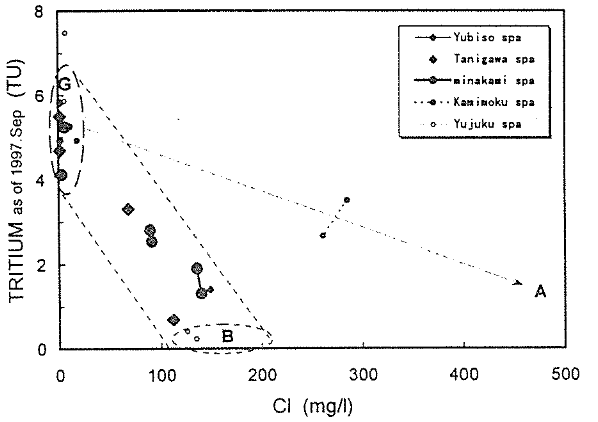
## Discharge processes of deep thermal water in a non-volcanic region, North Gunma, Japan, from the viewpoint of tritium

*Kitaoka, K. and Sakai, Y.*

Tritium contents in hot spring waters in a non-volcanic region, the northern part of Gunma prefecture, have linear correlation with chloride concentrations and temperatures. Hot spring waters are formed through the rapid mixing between a tritium-free thermal water derived from depths and shallow circulating meteoric waters. The deep thermal water, which is of meteoric origin from hydrogen and oxygen isotopic data, is shown to be old meteoric water more than at least 45 years from its tritium content. Such the thermal water must be formed by water-rock interactions through a deep circulation in fractured systems. The tritium content in hot spring water is useful for discussing hot-spring conservation and discharge processes of deep thermal waters.



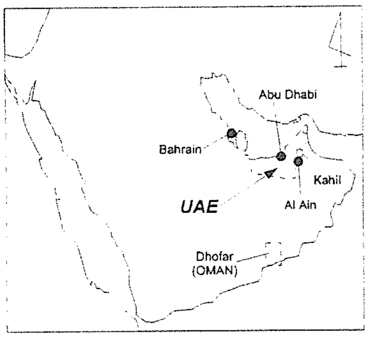

Temperature and chloride relations in hot spring waters, cold spring waters and river waters in the north Gunma



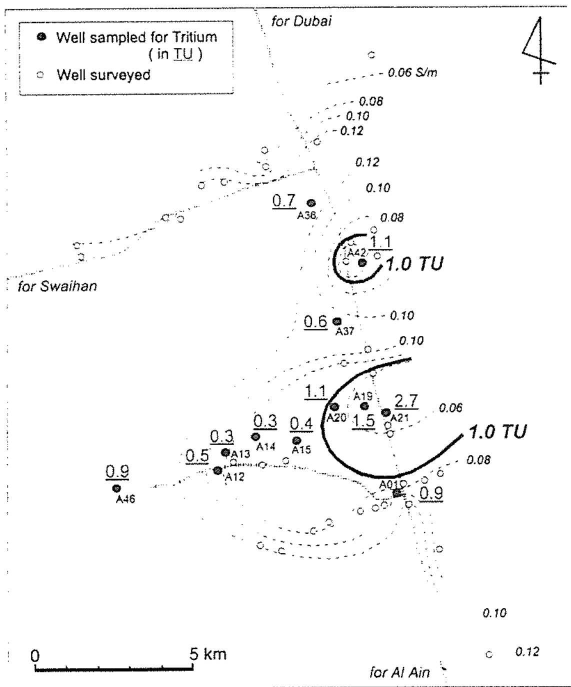

Tritium and chloride relations for hot spring waters, cold spring waters and river waters in the north Gunma

## Recharge processes to groundwater system beneath the desert of the United Arab Emirates from the viewpoint of tritium

*Kitaoka, K., Sakura, S., Machida, I. and Okada, M.*




Groundwater occurs at about 30 m depth beneath the desert, in the inland area (Kahil Area) of the United Arab Emirates, although the environment is exceedingly dry as annual rainfall of about 70 mm and potential evaporation of several thousands mm. Tritium concentrations of the groundwaters collected in November 1994 fall into a limited range from 0.3 to 2.7 TU, which is relatively low compared with those of most groundwaters in Japan, although tritium levels in rain water in the area are similar to those in Japan. Some of the greater tritium concentrations of groundwaters in the area are similar to those of stream waters in the mountain region several tens kilometers away. Groundwaters with several TUs concentration distribute widely (mainly along wadi courses) and the recharge to the groundwater system occurs in many parts along wadi courses in the area. It is likely that the recharge source was rainstorm (flooding) during pluvial periods in the past to the aquifer along wadi courses. By comparing the tritium concentrations of the groundwater with those in the rainfall, the transit time of meteoric water through the unsaturated zone is estimated to be around 40 years. The transit time corresponds to the annual recharge of around 120 mm for the water content



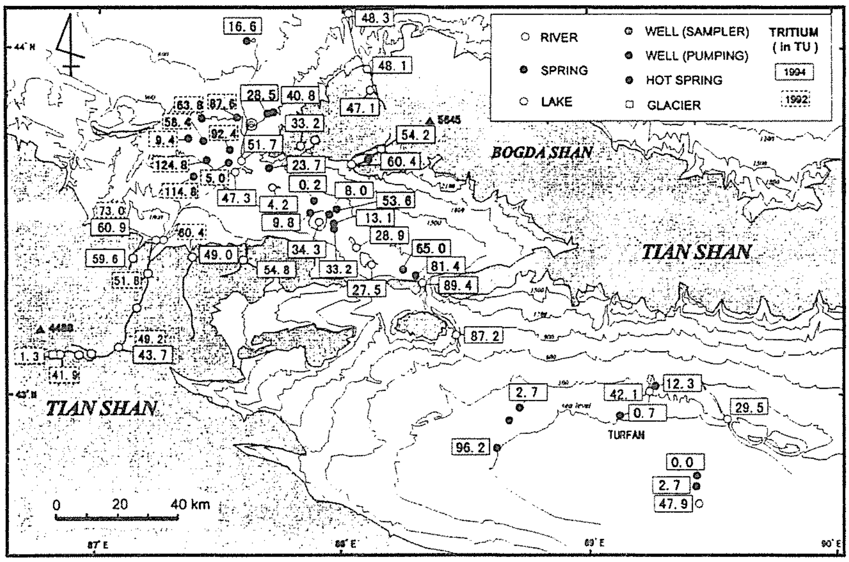

Solid lines indicate the 1.0 TU isoleth. Contours of dotted lines are electrical conductivity in S/m.

of 0.14. The mean residence time of groundwater in the aquifer is estimated to be 20 to 40 years.

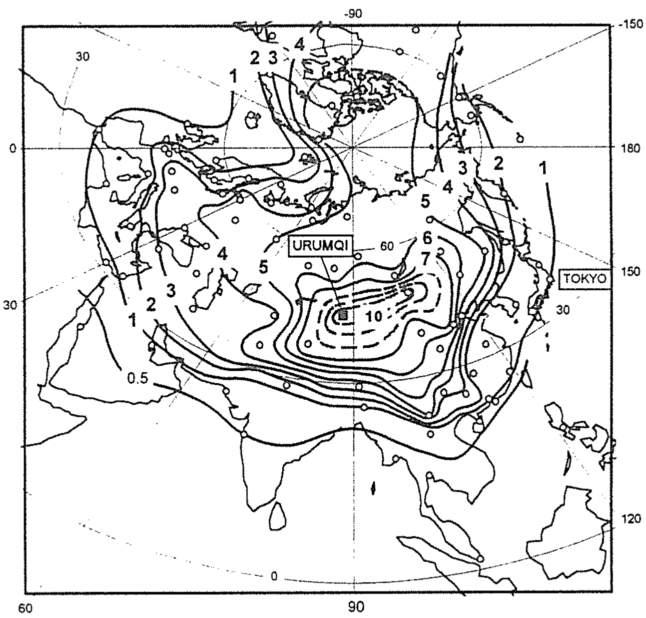
## Tritium hydrology in semi-arid areas around the Tianshan Mountains, Western China

***Kitaoka, K.,** Horiuchi, S., Watanabe, M., Okuda, S., Mu, G, and Zhou, Z.*

To investigate the water circulation in the semi-arid region with glacier at the river head, tritium study was made in Urumqi and Turfan areas in Xinjiang, western China. Tritium contents in river waters, groundwaters, spring waters, lake waters and glacier ice collected in summers in 1992, 1994 and 1997 are in a wide range from 0 to 125 TU, most of which are considerably high compared with those of most natural waters in Japan. Tritium levels in precipitation in the area are over ten times as high as those in Japan. Groundwaters, spring waters and lake waters in the flat regions are mainly derived from river waters originating in glacier regions. Tritium contents in river water show that river waters contain about 65% melt glacier and the part of circulating meteoric water in river water has spent a mean time of about 16 years in groundwater systems in the mountain regions. River waters take several ten years to pass the underground to many springs and wells in the flat regions. The low tritium concentrations in some groundwaters and spring waters are corresponded to those in river waters more than 40 years ago. For closed and semi-closed lakes, the ratios of groundwater inflow to salt lakes to precipitation are relatively small as against those in fresh water lakes, taking into consideration for tritium enrichment in lake water by evaporation.




TU values in 1992 and 1994 for river waters, spring waters, groundwaters, lake waters, and glacier ice in Urumqi and Turfan areas, Xinjiang, China




Distribution of tritium concentration (annual mean) in precipitation in Eurasia (based on IAEA data). Figure denotes a factor to be multiplied by the annual mean at Tokyo.

**Building the network system at BGRL**

*Mawatari, H*

The following network system is now available at BGRL ( Fig 1 ) :
1 Since August 1997, Internet has been accessible through NTT-OCN with NAT+ and packet-filtering for high security on our gateway.
2 A new zone "vgs" has been used for e-mail and WWW-services. Two name-servers are running.
3 Two SMTP-receivers, main and back-up, are running by use of MX-records.
4 One file-server and one print-server are accessible from both Macintosh and Windows PCs.
5 Two PPP-servers are running for the remote connection through NTT cables.

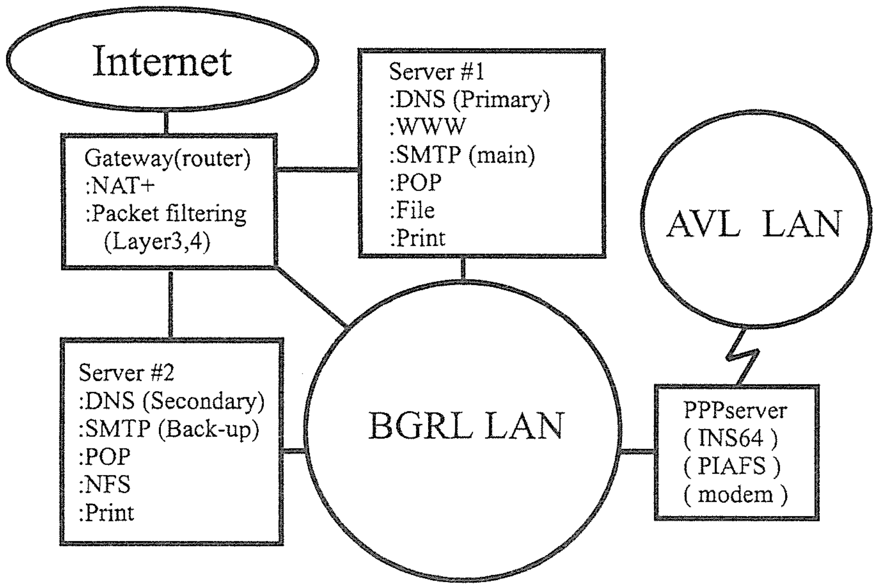



Fig 1 Summary of the network system at BGRL

**Seismic observation at a geyser in Tsuwano**

*Mori, T., Sudo, Y., Yoshikawa, S., Nakaboh, M., Gabriel, L.C., Hashimoto, T., Tsutsui, T., Kikuchi, S., Ono, H., Masuda, H., Hoka, T., Sako, M., Yamada, T. and Tanaka, M.*

A geyser was generated in Tsuwano town, Yamaguchi pref. in May, 1997. It blows up the hotspring water up to the height of 30m. It has already been known that seismic motion can be generated by extrusion activity like a geyser. It is supposed that such seismic motion is a result of the pressure change according to the movement of the geothermal fluid in the conduit. In August of 1997, we did a preliminary investigation on the relation between the hydrothermal eruption activity and the seismic motion associated with it.

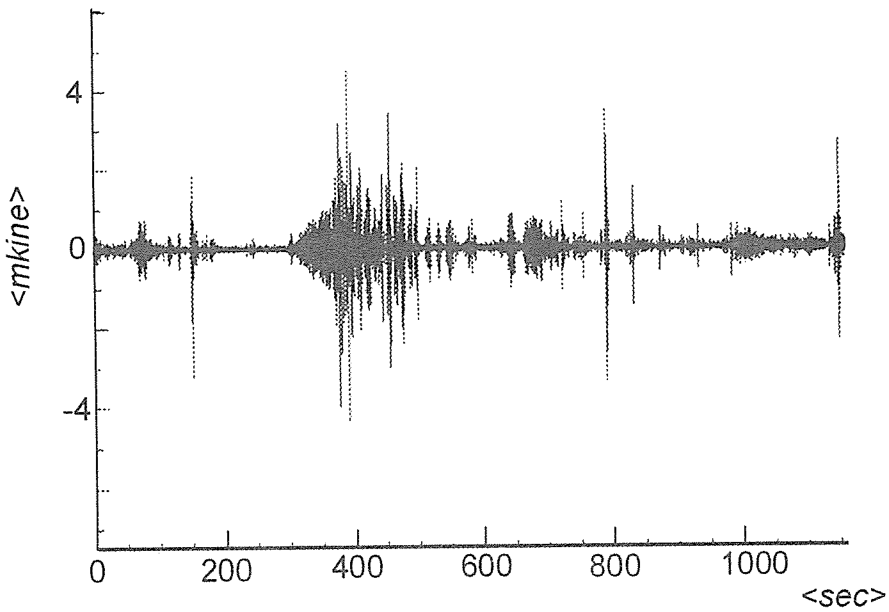



Fig. 1 Seismic trace of vertical component observed at Tsuwano geyser.

**Short-period volcanic tremor observed at the crater rim of Mt. Nakadake, Aso volcano**

*Mori, T., Yoshikawa, S., Sudo, Y., Tsutsui, T., Hoka, T., Sako, M., Masuda, H., Yamada, T., Kikuchi, S., Ono, H., Tanaka, M., Nakaboh, M. and Hashimoto, T.*

We have observed the short-period volcanic tremor in the crater rim on the west side of 1st crater of Mt. Nakadake since 1996. An array measurement at three points with short-period seismometers was done with the observation by a lot of long-period seismometers in August, 1997. It was found that most of the volcanic micro tremors with dominant frequency at 10Hz take place in the very shallow part beneath the 2nd crater. The initial motion of these volcanic tremors is unclear though volcanic earthquakes which occur beneath the craters have a clear initial motion. Moreover, this volcanic tremor is different in frequency from general volcanic earthquakes. Therefore, we think that this volcanic tremor is a seismic event with a different generation mechanism from volcanic earthquakes.

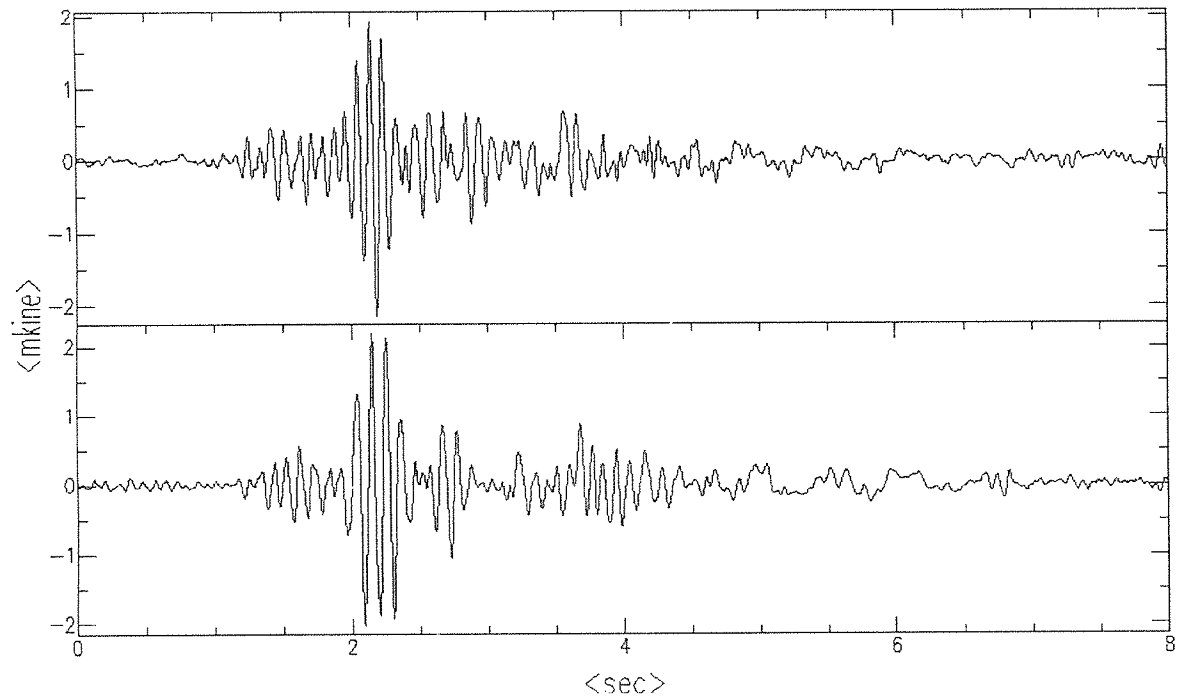



Fig. 1 Seismic trace of vertical component observed in Mt. Nakadake. Upper trace is a record at 17:40 on February 2, 1997. Lower trace is a record at 21:18 on February 2, 1997.

## Ground deformation of Kuju Volcano

*Nakaboh, M., Ono, H., Sako, M., Sudo, Y., Kikuchi, S., Tsutsui, T., Mori, T., Tanaka, M., Masuda, H., Yamada, T., Hoka, H., Hashimoto, T.* and *Nishi, K.*

Kuju volcano erupted on Octover, 1995 after 250 years dormancy. Fumarole activity from new craters and ground deformation near the craters have continued for 2.5 years after the eruption. EDM surveys have been carried out after the eruption.

Distances along several base lines near the new crater showed predominant contraction. For example, the contraction for 30months was -34cm to distance 1110m, SGM-HSS and is correspond to $-3x10^{-4}$ strain. It was computed by Mogi's model that the source of contraction located at 500m beneath the crater. The deformed volume of ground correspond with 20% of water emitted by fumarole from the crater.

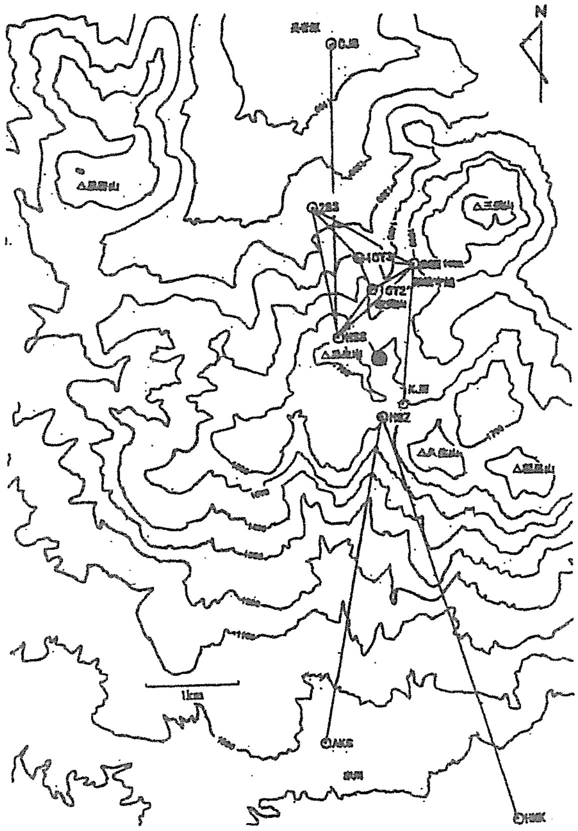


Figure 1. Location map of EDM base lines at Kuju Volcano and new crater indicated by ●

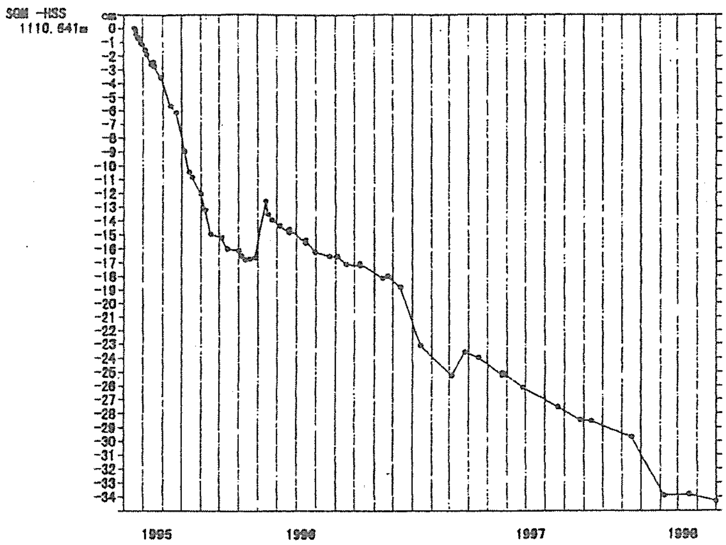



Figure 2. Variation of distance SGM-HSS.

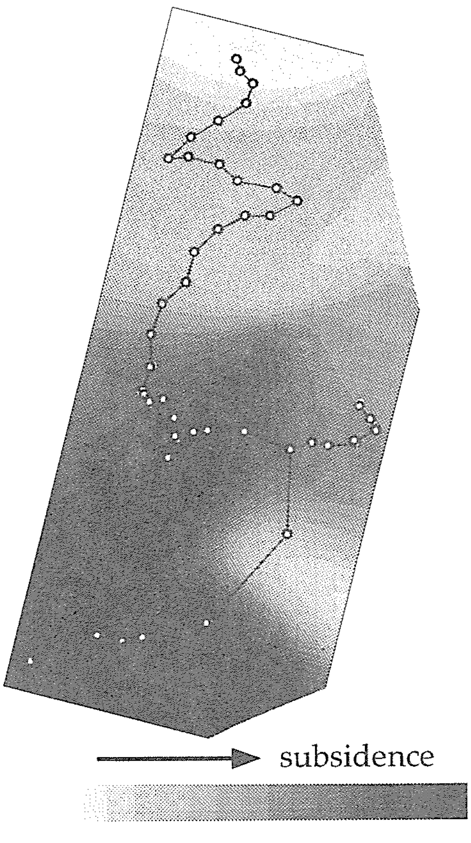
# Leveling survey at Aso Volcano

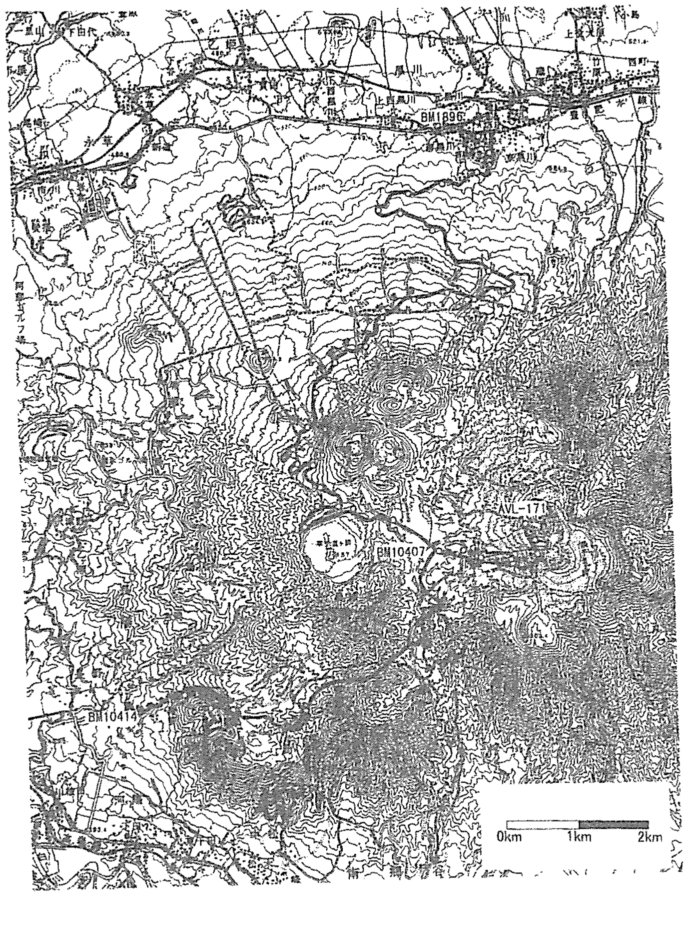
*Nakaboh, M., Sako, M., Hoka, T., Masuda, H., Yamada, T., Yoshikawa, S., Hashimoto, T., Tsutsui, T., Sudo, Y., Ono, H., Mori, T.* and *Kikuchi, S.*

Leveling survey is the most precise measurement to obtain vertical ground deformation data. Since 1937, Aso Volcanological Laboratory (AVL) has made leveling measurements 14 times at Aso Volcano. The length of the survey line is about 17km. In May 1997, we made 15th leveling survey after 4 years since 1993 . Vertical ground deformation from 1993 to 1997 indicates that there was a subsidence zone between Mt. Kishima and Furubouchu. This subsidence zone is in accord with the trend of the vertical ground deformation from 1958 to 1997. The leveling data, however, wasn't enough to relate the ground deformation to the volcanic activity because we had no south-side leveling data of Aso Volcano. Hence, we made new leveling survey at south-west side of Aso Volcano in November 1997 to estimate how the subsidence zone extends. This leveling route was constructed by Geographical Survey Institute (GSI) in 1989. The results of the measurement in 1997 are the followings.

1) The subsidence zone extends to Jigoku-Tarutama hot spring area.
2) With a Mogi (spherical chamber) model, the leveling data can be explained by a deflation source between Kusasenri, Yunotani, Jigoku and Mt. Eboshi.

**Fig. Vertical ground deformation by leveling survey from 1993 to 1997.**
**(Right panel shows survey route.)**



## Geothermal exploration on Garan-dake, Ohita prefecture

*Oba, S., Tanaka, Y. and Hashimoto,T.*

We conducted self-potential (SP) mapping and DC electric resistivity sounding around Garan-dake geothermal field. The self-potential measurements revealed that there existed a prominent positive SP anomaly up to 1300mV in this region. The anomaly, which lies around a fumarolic area of Garan-dake with radius of more than 300m, is supposed to be caused by the two-phase flow just under the fumaroles. The DC electric resistivity sounding revealed that the conductive zone corresponding to the fumarolic area reached to the depth of several hundred meters. On the other hand, the summit area was found to be resistive. The resistivity difference is probably corresponds to the geological difference between acid-alteration zone and non-altered zone.

The positive SP anomaly extends out of the target filed. The size of the anomaly indicates that of subsurface two-phase convection cell, and hence, it is important to extend the target area and to grasp the whole profile of the anomaly. That will be a help in understanding the hydrological and geothermal system around the area. The ground resistivity around Garan-dake has spatially wide range of variety. It is suggested that the spatial variation of the resistivity considerably affect the SP distribution. Self-potential modeling taking the resistivity structure into consideration is required for further interpretation.

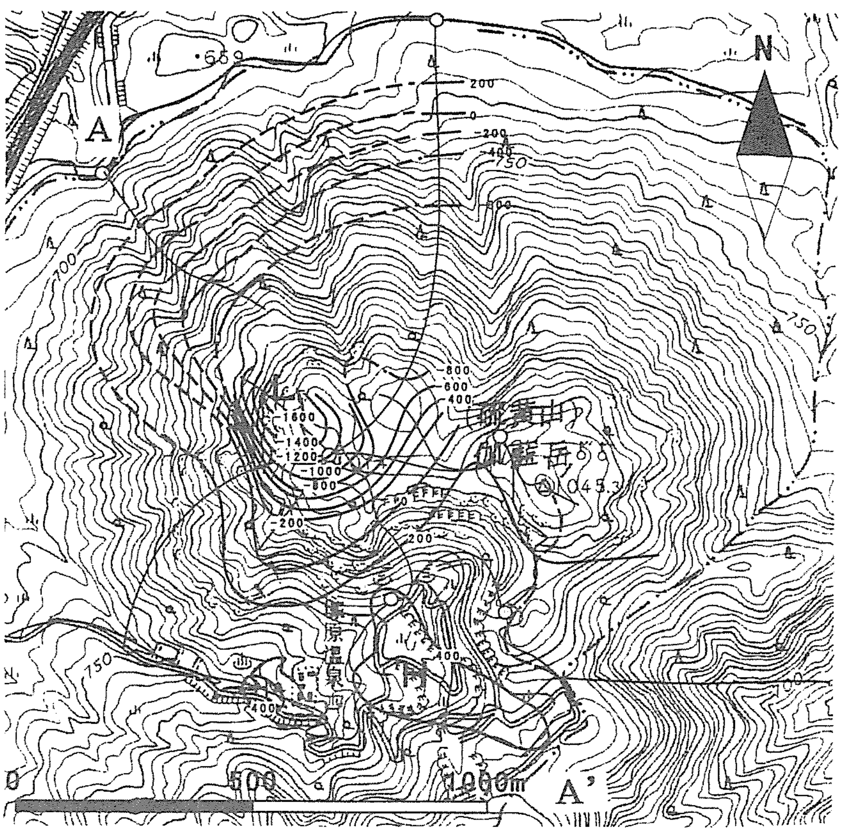



Fig.1 Self-potential profile around Garan-dake geothermal field. SP values are indicated in units of millivolts.

**Isotopic Characteristics of Typhonic Rainwater :**
**Typhoons No. 13, 1993 and No. 6, 1996 Struck Japan**

*Ohsawa, S.*

The stable isotope ratios of hydrogen and oxygen were measured for rainwaters from Typhoons No. 13 on September 1993 and No. 6 on July 1996 struck Japan. Rainwater was successively collected every one hour over 2 or 3 days at Beppu, Japan (33°16′N, 131°29′E) located on the typhoon routes, while barometric pressure, precipitation and air temperature were also measured. It became clear that d-excess parameters of the typhonic rainwaters vary over wide ranges from 19.22 to 1.52 for Typhoon No. 13, 1993 and from 6.02 to -8.10 for Typhoon No. 6, 1996 respectively. From an examination of the time-varying d-excess parameter of precipitation of the typhoons, it was shown that rainwaters of high d precipitated in the forward area of the typhonic centers (Group I), whereas the rainwaters of low d fell in the rearward area (Group II). This indicates that the water vapors supplied by the counterclockwise bottom air currents from the front and the rear of the typhoons should be formed by rapid and gentle evaporations of sea water respectively. General trend of spatial $\delta D$ and $\delta^{18}O$ distributions of the typhoon precipitation, estimated from the variations in the isotope ratios of the typhonic rainwaters, show that Rayleigh distillations of water vapors with the bottom air currents in the forward and the rearward areas of eye of typhoon may progress moderately and intensively respectively. Weighted mean values of $\delta D$ and $\delta^{18}O$ of the typhoon precipitations, which are smaller than those of usual rainfall, suggest that isotopic influence of typhonic precipitation to surface waters ; e.g. river, stream, lake and spring waters, would not be negligible.

Fig. 1 Map showing routes of typhoons No.13, 1993 and No.6, 1996 in and around Japan Islands with sampling and observational location. Black circles adjacent to dates on the routes indicate via points of eye of typhoons at each 9 a.m. Small open circles show points at which the typhoons turned into temperate cyclones. Words in parentheses are American names of the typhoons.

Fig. 2 Changes with time of d-excess parameter, $\delta D$ and $\delta^{18}O$ of rainwater, barometric pressure and precipitation as regards Typhoons No.13, 1993 and No.6, 1996.

Fig. 3 A conceptual model explaining variations in d-excess parameter, $\delta D$ and $\delta^{18}O$ of successively collected rainwaters from the typhoons.

(Submitted to Geochemical Journal)

*Fig. 1*

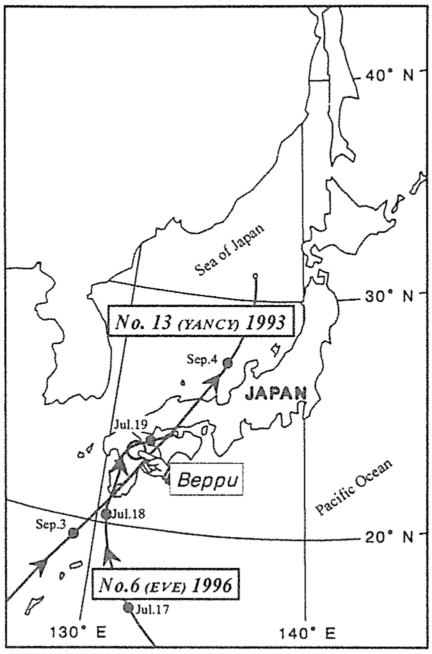



*Fig. 3*

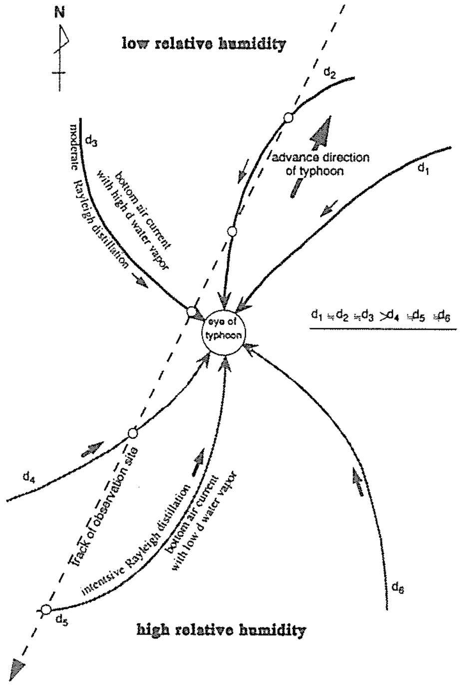
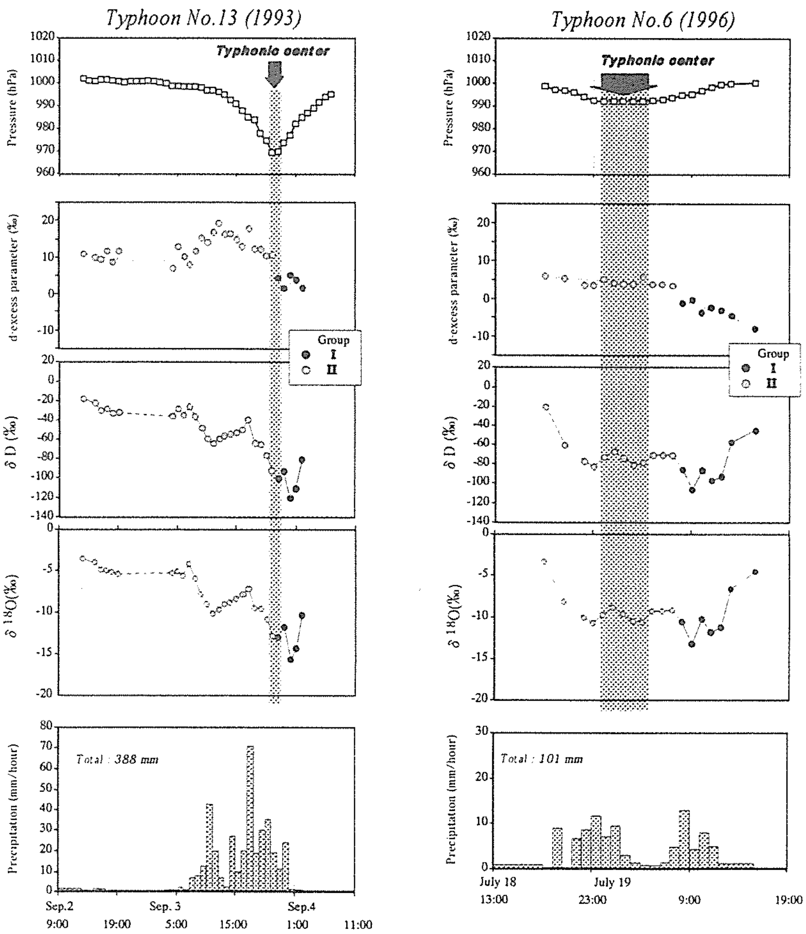



*Fig. 2*



## Chemical Compositions of Gases Discharged from Fumaroles and Steam Wells in the Takenoyu Geothermal Area, Kyushu, Japan

*Ohsawa, S., Yusa, Y. and Oue, K.*

There are many fumaroles and steam wells in the Takenoyu geothermal area, which are located about 10km in the west of Kuju volcano, Central Kyushu, Japan. Geothermal gas samples for chemical analysis were collected there and eight components ($H_2O$, $CO_2$, $H_2S$, He, $H_2$, Ar, $N_2$ and $CH_4$) in the samples were analyzed. The gas samples have 0.35 - 0.87mol % of noncondensable gases. The chemical compositions of the noncondensable gases are summarized as follows : 92% of $CO_2$, 5.8% of $N_2$, 1.3% of $H_2S$, 0.32% of $H_2$, 0.26% of $CH_4$, 0.10% of Ar and 0.0019% of He. He/Ar ratios of the Takenoyu geothermal gases ranging 0.017 - 0.024 are lower than those of fumarolic gases discharged from Kuju volcano : 0.034 - 0.31. Relative He, $N_2$ and Ar contents of the gases from the Takenoyu area indicate that the geothermal gas nearly consists of meteoric gas such as air and/or dissolved air in cold groundwater. This result of the geochemical analysis shows that there will be a meteoric-dominated hydrothermal system under the Takenoyu geothermal area. Data plotted on the log($CO_2$/Ar)-log($H_2$/Ar) diagram (Giggenbach and Goguel, 1989) indicate that the gases discharged from the Takenoyu area are originally dissolved in a equilibrium liquid with water vapor at 200 - 250℃. The estimated underground temperature is comparable with the maximum temperature observed in geothermal drill holes (214℃) and is also nearly in accordance with estimated temperatures by other methods, for example 235℃ from chemical composition of thermal water and 200-250℃ from formation of altered minerals.

Fig. 1 Location map of gas sampling in the Takenoyu geothermal area.

Fig. 2 Relative He, $N_2$ and Ar contents of gases discharged from the Takenoyu geothermal area (TK ; Takenoyu, HG ; Hagenoyu).

Fig. 3 $H_2$/Ar$-$$CO_2$/Ar diagram for gases discharged from the Takenoyu geothermal system (TK ; Takenoyu, HG ; Hagenoyu).

(Submitted to J. Geotherm. Res. Soc. Japan)

*Fig. 1*

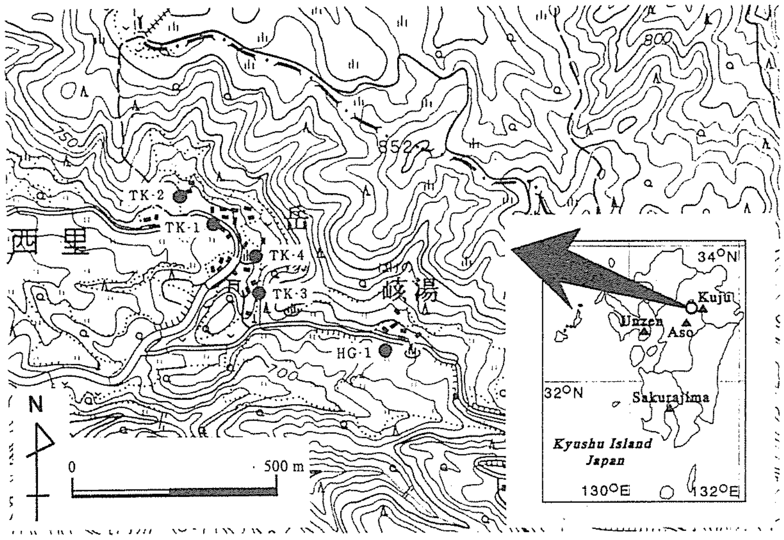



*Fig. 2*

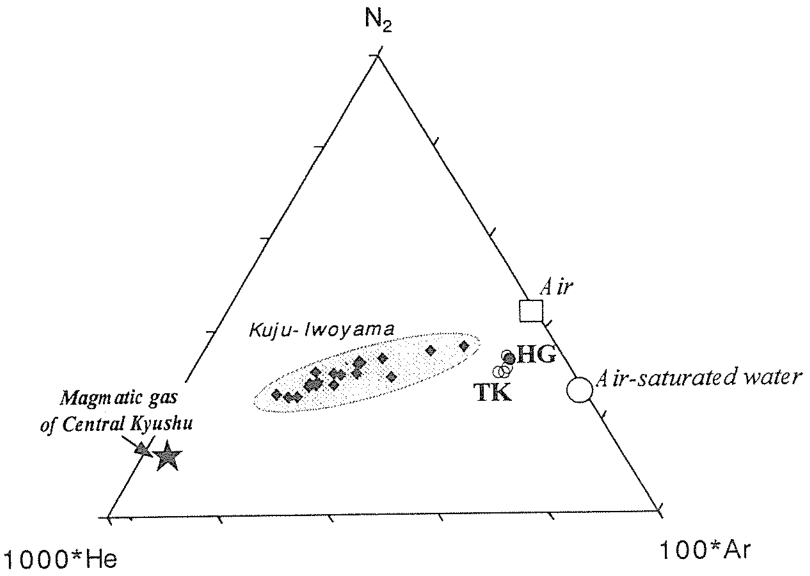
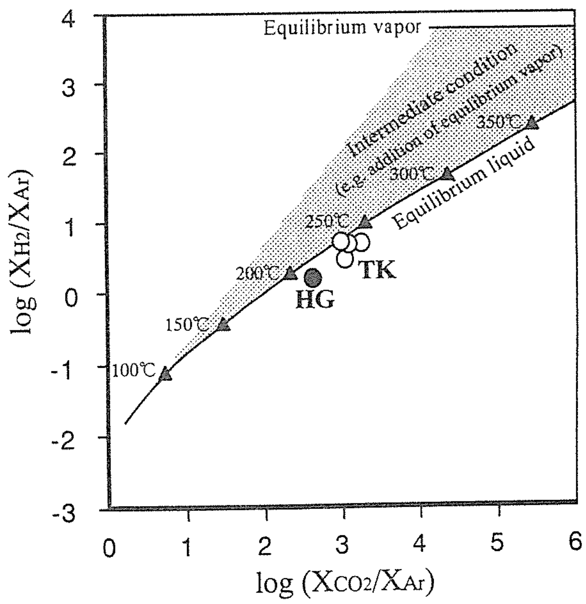



*Fig. 3*



**Entrainment of Atmospheric Air into the Volcanic System during the 1995 Phreatic Eruption of Kuju Volcano, Japan**

*Ohsawa, S., Yusa, Y., Oue, K. and Amita, K.*

After at least 333 years dormancy, on October 11 of 1995 Kuju volcano (Central Kyushu, Japan) erupted steam and ash from new vents opened south of the active Kuju-Iwoyama fumarole area. Since the last ash ejection of January 13, 1996 and up to the time of this writing, heat flux measurements suggest that steam emissions at the new vents have been slowly declining. The He/Ar atomic ratio of fumarolic gas discharged from Kuju-Iwoyama, which is determined by the ratio of magmatic gas to air, suddenly decreased from 0.12–0.22 to 0.04–0.06 with the beginning of the 1995 eruption. Magmatic He flux from the fumaroles soon after the eruption is calculated to be nearly 12 times as large as before the eruption : values before and soon after the eruption are $57 \times 10^{-3}$ kg/day and $694 \times 10^{-3}$ kg/day respectively. In contrast, air-derived He flux from the fumaroles after the eruption increased by nearly 42 times compared with that before the event : values before and soon after the eruption are $0.2 \times 10^{-3}$ kg/day and $7.6 \times 10^{-3}$ kg/day respectively. The steep decline of the He/Ar ratio suggests that atmospheric air may have been suctioned into the volcanic edifice by a shallow low-pressure region formed by gas accelerating through a constriction in a volcanic conduit. The volume of atmospheric air entrained by the increased flow of the magmatic gas in the volcanic conduit is estimated to be nearly 20 cubic meters per day.

Fig. 1 Location map showing Kuju-Iwoyama, Kuju volcano. Unzen volcano on which several lava domes were formed from 1991 untill 1995 is located about 100km in the west-southwest of Kuju volcano. The 1995 eruption occured at the D-region in the east of Mt. Hossho. A-, A'-, B- and C-regions facing the D-region are fumarolic areas which has been active before the eruption.

Fig. 2 Temporal variation of the He/Ar ratio of fumarolic gas discharged from Kuju-Iwoyama before and after the 1995 eruption. Data in 1984 are quoted from Mizutani et al. (1986). The He/Ar ratios of fumarolic gases should take on values from 2 to 0.0006 depending on the mixing ratio between magmatic gas and air.

Fig. 3 A schematic model showing entrainment of atmospheric air (air-suction) into the volcanic system during the 1995 phreatic eruption of Kuju volcano.

(Subnitted to J. Volcanol. Geotherm. Res.)

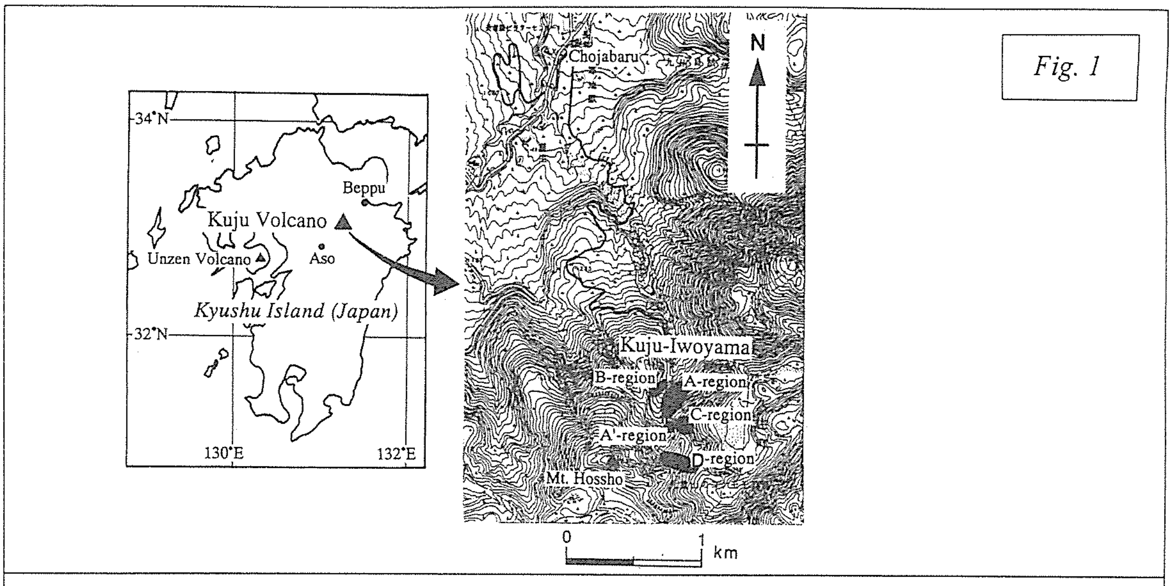


Fig. 1
34°N
32°N
130°E
132°E
Beppu
Kuju Volcano
Unzen Volcano
Aso
Kyushu Island (Japan)
Chojabaru
N
Kuju-Iwoyama
B-region
A-region
C-region
A'-region
D-region
Mt. Hossho
0
1 km

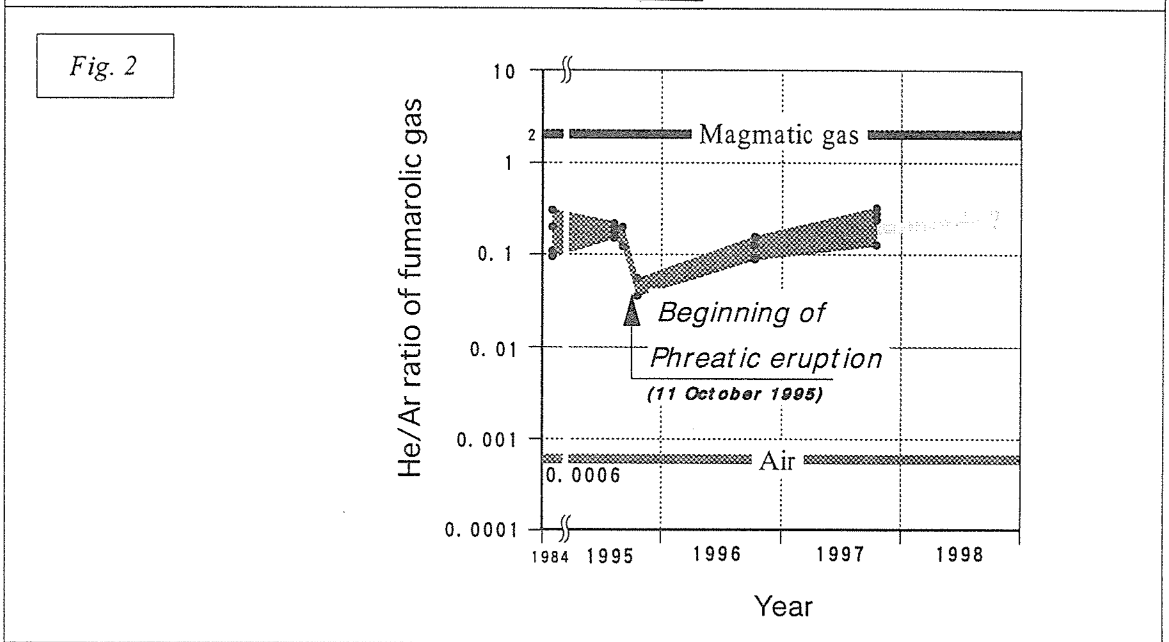


Fig. 2
He/Ar ratio of fumarolic gas
10
2
1
0. 1
0. 01
0. 001
0. 0006
0. 0001
Magmatic gas
Beginning of
Phreatic eruption
(11 October 1995)
Air
1984
1995
1996
1997
1998
Year

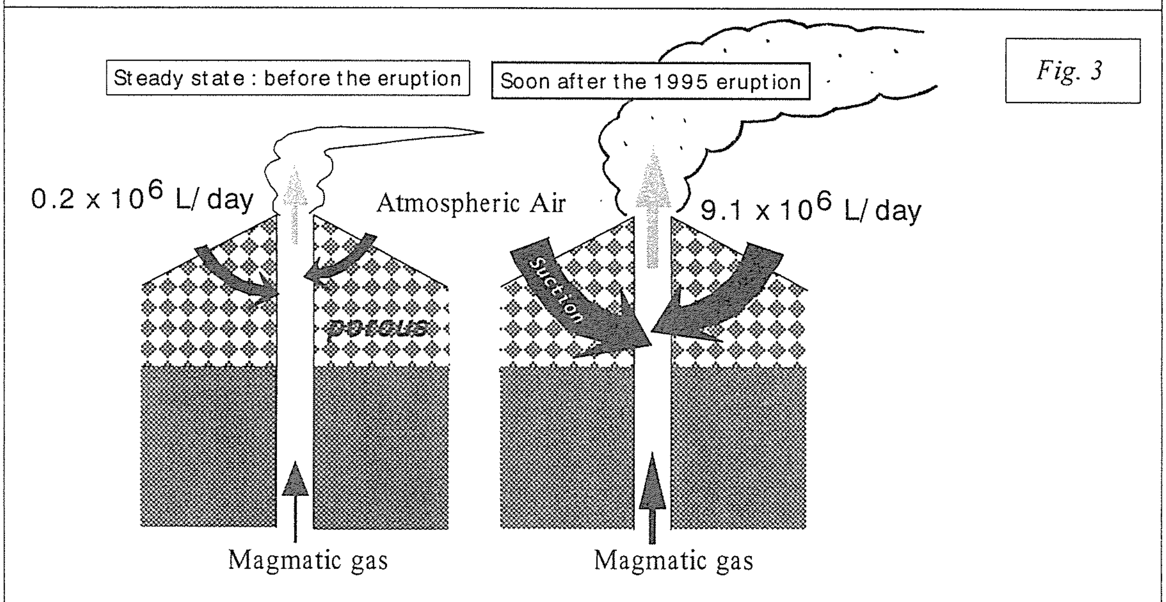


Fig. 3
Steady state : before the eruption
Soon after the 1995 eruption
0.2 x 10⁶ L/ day
Atmospheric Air
9.1 x 10⁶ L/ day
Suction
Magmatic gas
Magmatic gas

## Low $N_2$ /He Ratio Magmatic Gas Discharged from Ogasawara-Iwojima in Izu-Mariana Arc along an Oceanic Subduction Zone between Pacific and Philippine-sea Plates

*Ohsawa, S., Yusa, Y., Oue, K. and Kitaoka, K.*

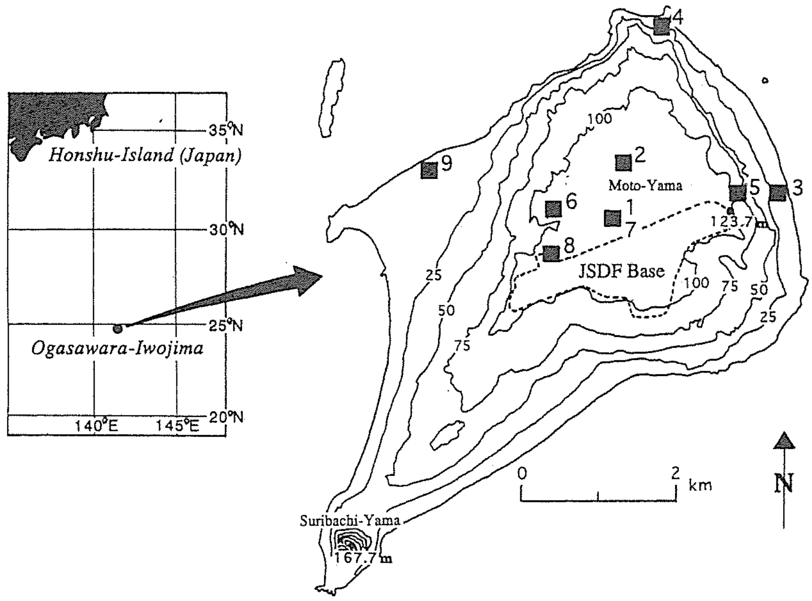
Fumarolic gas samples were collected from Ogasawara-Iwojima Island on the Izu-Mariana arc, which is located along a convergent margin between Pacific and Philippine-sea plates. Along the margin, the Pacific plate putting on thick oceanic sediments subducts beneath the Philippine-sea plate, on which accretionary prism (sedimentary basement and/or metamorphic rocks originated from sedimentary rock) is not well-developed. Trends of inert gas compositions (He-Ar-$N_2$) indicate that $N_2$/He ratio of magmatic gas ascending to the Ogasawara-Iwojima Island from deep is nearly 20, which is considerably lower than the lowest value (170) observed in the Japanese main-land and is in the same order of the mantle value (10). These characteristics strongly support the new model proposed by Ohsawa et al. (1997), in which $N_2$-poor magmatic gas ascending from mantle along subduction-zone is given $N_2$ as contaminant from basement rocks containing nitrogen compounds. Variety of $N_2$ contents ($N_2$/He ratios) of magmatic gases in subduction-zones is not resulted from difference of physical and chemical states of subducting plates, but will be reflection of geochemical heterogeneity of crust.

Fig. 1 Map showing location of the Ogsawara-Iwojima Island (solid circle) and sampling sites for chemical analyses of fumarolic gases in the island (solid quadrilateral) .

Fig. 2 Relative He, Ar and $N_2$ contents of fumarolic gases from the Ogasawara-Iwojima Island. Data of fumarolic gases from Kyushu Island, Japan are also plotted on the diagram. The solid rhombus indicates magmatic gas of Japan excluding Central Kyushu interpretated from the estimated value by Kiyosu (1986) and the solid asterisk shows magmatic gas of Central Kyushu inferred from Mt. Unzen Fugen-dake collected by Hirabayashi et al. (1993). The small open circle attaching A represents estimated magmatic gas from the Ogasawara-Iwojima Island. The thick and thin solid lines show mixing lines between the magmatic gases and air. Magmatic gases in the whole world will be on the broken line. ASW means Air-saturated water.

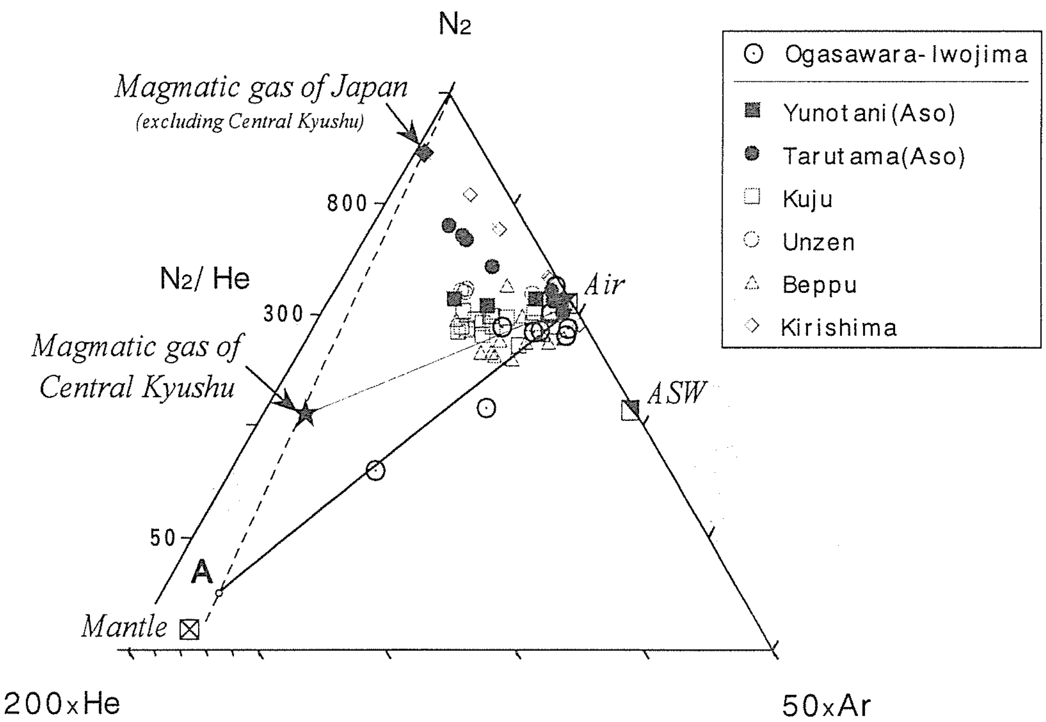
(J. Balneological Soc. Japan in press)

*Fig. 1*



35°N
Honshu-Island (Japan)
30°N
25°N
Ogasawara-Iwojima
20°N
140°E
145°E
4
100
2
Moto-Yama
9
6
1
7
5
3
123.7m
8
JSDF Base
25
50
75
100
75
50
25
0
2
km
N
Suribachi-Yama
167.7m


*Fig. 2*



N2
Magmatic gas of Japan
(excluding Central Kyushu)
800
N2/ He
300
Magmatic gas of
Central Kyushu
50
A
Mantle
Air
ASW
200xHe
50xAr
Ogasawara-Iwojima
Yunotani (Aso)
Tarutama(Aso)
Kuju
Unzen
Beppu
Kirishima

**Volcanic earthquakes near Naka-dake, Aso Volcano**

***Ono, H.***

Volcanic earthquakes located beneath the active 1st crater of Naka-dake. The location of deeper source shift to east. Volcanic earthquake near the Naka-dake do not occur below 3km depth under sea level. Earthquake activity precedes surface activity of volcano. Shallow earthquake increase above 1km under sea level in the period of active stage. Most of shallow earthquake are low frequency earthquake which has predominant frequency below 7Hz. High frequency earthquakes located under sea level and occur also in the period of calm stage. The source area didn't change for 20 years except the earthquakes under Kishima-dake which occurred on September, 1978.

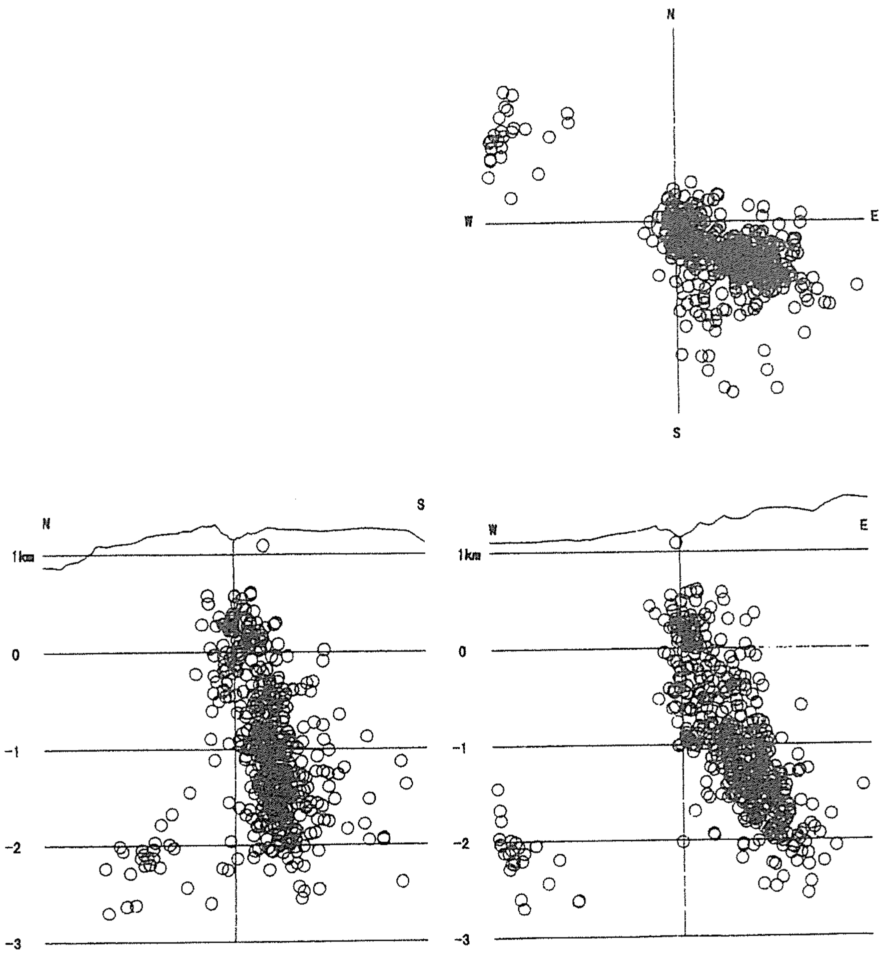



Figure 1. Source distribution of volcanic earthquakes near Naka-dake from 1977 to 1997.

## Volcanic activity of Kuju volcano, Kyushu in 1995 deduced from GPS surveys.

***Ono, H., Kikuchi, S.*** *and Nishi, K.*

Kuju volcano erupted on October, 1995 after 250 years dormancy. Fumarole activity from the new craters and ground deformation near the craters have continued for 2.5 years after the eruption.

GPS surveys were carried out 12 times around Kuju volcano from November, 1995 to March, 1998. Predominant variation of dilatation around Kuju volcano was not detected except for decrease about two months after the eruption that was estimated from the variation of slope distances by GPS measurements. It is inferred that deeper magma didn't intrude to new craters.

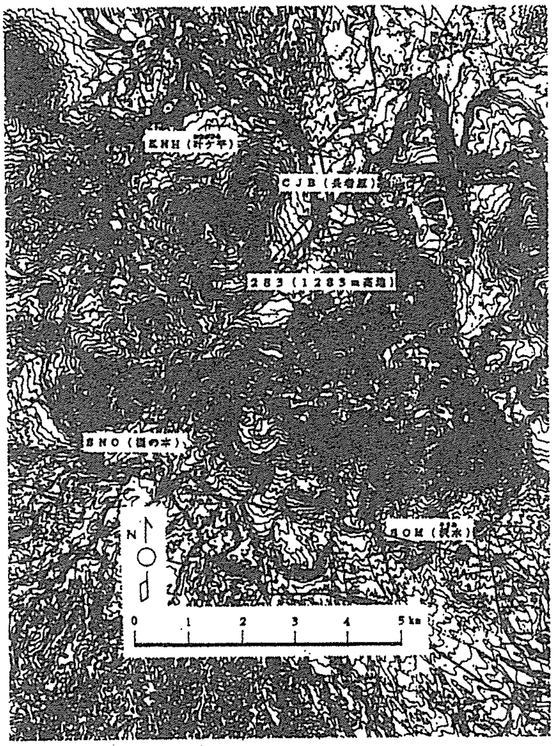



Figure 1. Location map of GPS survey and new crater in 1995.

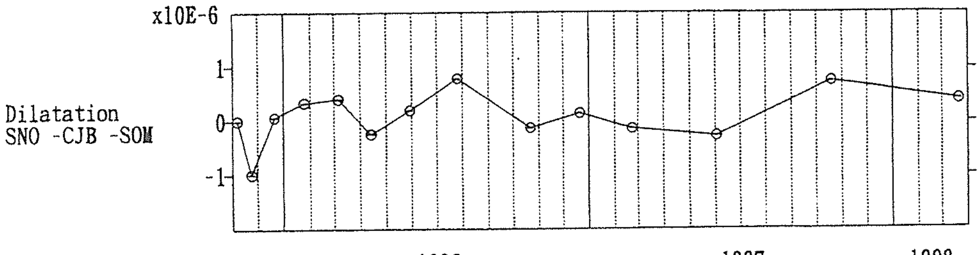



Figure 2. Variation of dilatation for the triangle SNO-SOM-CJB.

## Ground deformation around Aso Volcano

*Ono, H., Sako, M., Kikuchi, S., Hoka, T., Masuda, H., Yamada, T., Mori, T., Sudo, Y., Tsutsui, T., Nakaboh, M., Tanaka, M.* and *Hashimoto, T.*

Electronic distance measurement(EDM) and grobal positioning system(GPS) survey were carried out around Aso Volcano to detect the ground deformation related to volcanic activity and the stress field of Aso caldera area.

Base lines over the crater tend to expand and base lines on west side area of the crater contract according to EDM near the Naka-dake in 1997. But changes of distance were less than 1cm for all base lines.

On GPS survey of 1996 and 1997 westward displacement to Aso Volcanological Laboratory(AVL) were observed at two stations located at the east of AVL in the Aso caldera and Asaji station located at 44km ENE of AVL. But these changes were less than $5 \times 10^{-7}$ strain.

## Accumulation Rates of Hot Spring Deposits Estimated by the $^{210}$Pb method
## - Case Study at the Chinoike-Jigoku Hot Pool in Beppu Geothermal Field, Japan -

*Oue, K., Ohsawa, S., Yusa, Y., Kitaoka, K.*

The $^{210}$Pb method developed for estimating accumulation rates of lake sediments was applied to layered hot spring deposits from the Chinoike-Jigoku hot pool in the Beppu geothermal field, Kyushu, Japan. Sediment core of 40cm long was taken by the use of a core sampler designed to drill through sediments without disturbance. A plot of depth versus $^{210}$Pb concentration shows that the deposits had been accumulating almost regularly at the lower part but the accumulation rate abruptly changed at 19cm deep ; the accumulation rates are $1.3 \pm 0.5$cm/year for the upper part (0 − 19cm) and $0.2 \pm 0.02$cm/year for the lower part (19 − 40cm). The upper part is waterier than the lower part so that the abrupt change is likely to be caused by declining of sediment compression resulting from sudden decrease of the amount of the deposits around 10 years ago. From the result of this study, the $^{210}$Pb method can be utilized for estimating accumulation rate of hot spring sediment. The result also indicates that the deposits obtained can be traced back to about 100 years ago at least. We are planning to make clear secular mineralogical and chromatic changes of the Chinoike-Jigoku hot spring deposits.

(Submitted to J. Geotherm. Res. Soc. Japan )

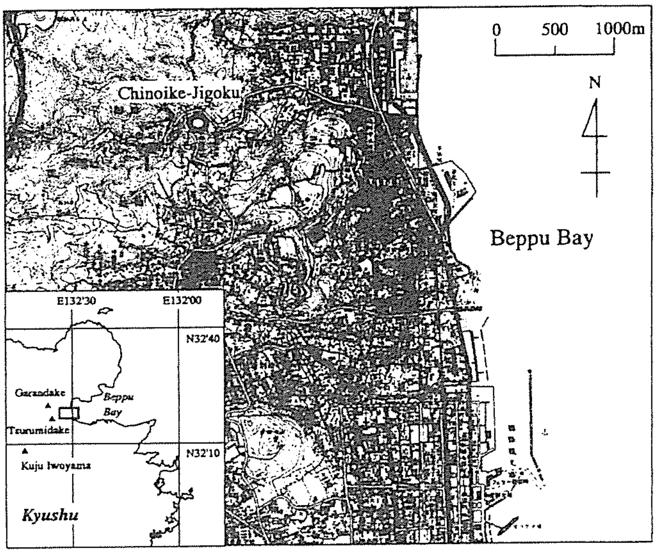



Fig. 1 Location map showing the Chinoike-Jigoku hot pool in Beppu city, Kyushu, Japan.

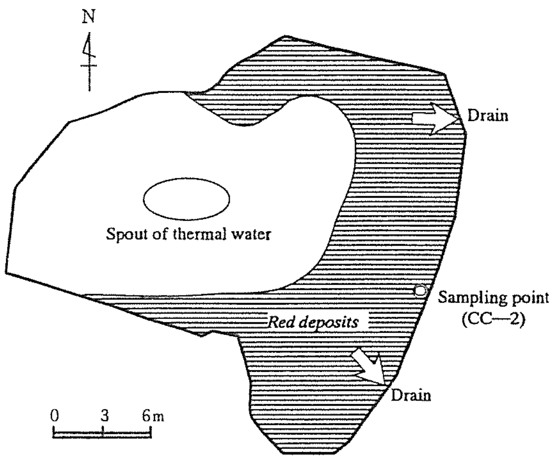



Fig. 2 Sampling site of sediment core of hot spring deposits at the Chinoike-Jigoku hot pool (CC-2).

Table 1 Results of $^{210}$Pb determinations of the CC-2 core samples from the Chinoike-Jigoku hot pool.

| Depth (cm) | $^{210}$Pb Activity (pCi/g) |
|---|---|
| 8 - 10 | 5.9±0.3 |
| 12 - 14 | 5.2±0.2 |
| 18 - 20 | 4.6±0.2 |
| 24 - 26 | 2.1±0.1 |
| 30 - 32 | 0.86±0.08 |
| 36 - 38 | 0.77±0.08 |

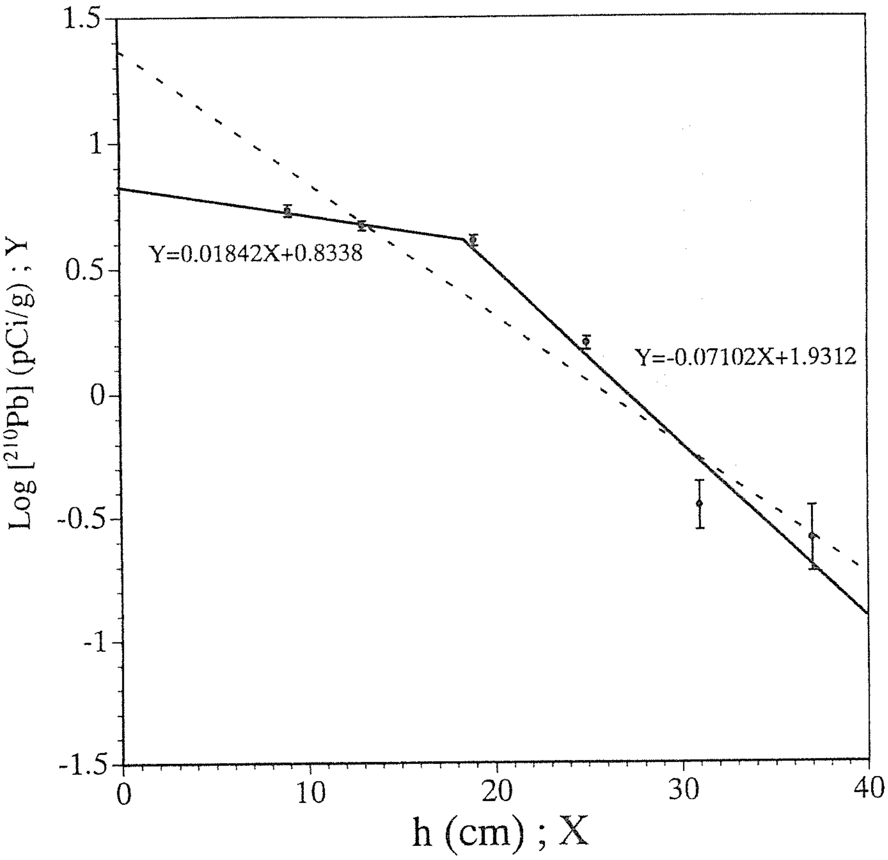



Fig. 3 Depth versus $^{210}$Pb concentration plot of the CC-2 core samples from the Chinoike-Jigoku hot pool.

## Study of Volcanic Tremor using Broadband Seismometers at Aso Volcano

*Sudo, Y., Tsutsui, T., Mori, T., Yoshikawa, S., Kawakatsu, H., Kaneshima, S., Ohminato, T., Ide, S., Yamamoto, M., Hoka, T., Masuda, H., Sako, M., Yamada, T., Nakaboh, M., Tanaka, M., Kikuchi, S., Ono, H. and Hashimoto, T.*

Broadband seismometers detected very low frequency volcanic tremor at Aso Volcano. These origins may be at about 1km depth just beneath the active crater. The goal is to study the characters of origins and of waves. In summer 1997, we installed many broadband seismometrs around the active crater.

## A research on the process of developing swarm activity, occuring in the foot of Kuju volcano

*Yoshikawa, M., Sudo, Y., Tsutsui, T., and Taguchi, S.*

There is a high-seismicity region lies north to northwest foot of Kuju volcano. The purpose of this research is estimate source mechanisms and declear the precise time variation of the seismicity and hypocentral distribution. This year, we deployed a new station in the target area and then collecting data.

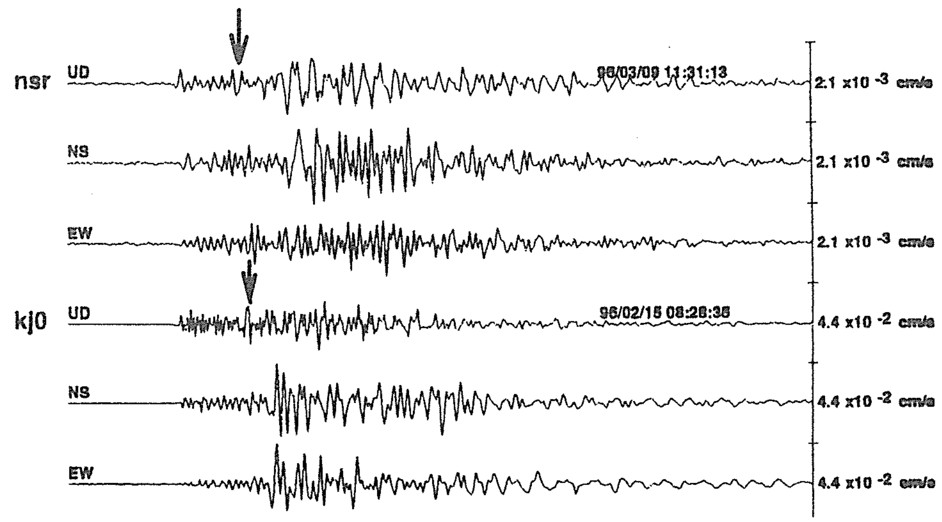



Fig. 1 Examples of the seismograms with the later phase.
The later phases are indicated with arrows.

**A research on the subsurface structure in Kuju volcano area by means of seismological approach**

*Tanaka, M. , Sudo, Y., and Tsutsui, T.*

A clear later phase appears preceding S phase in the seismograph for events in north or northwest adjacent of Kuju volcano. This phase is proved to be converted P wave from S wave and its conversion points are estimated. This conversion points are estimated to distribute beneath Kuju volcano and its adjacent and their depth range are about 1km below the surface.

## Investigation of thermal state using geomagnetic changes around active volcanoes

*Tanaka, Y. and Masuda, H.*

Thermal sensitivity of volcanic rocks lead us detection of thermal state underground by geomagnetic changes observed at the ground surface. Some proton magnetometers are operating near the active crater of Aso volcano to monitor of the mid-time scale activity. An fluxgate type three components magnetometer and a proton magnetometer are running routinely at AVL as references.

At the Unzen volcano, seven proton magnetometers were operated to study thermal diffusive effect of the intruded magma. At Kuju volcano, six proton magnetometers operated since phreatic eruptions occurred in the autumn, 1995, in cooperation with Kyushu university. The magnetic data showed increase of magnetization at shallow part of Hossho-yama, and cooling rate of about 500MW was estimated by the help of remagnetization nature of volcanic rocks. This cooling rate was roughly equal to the fumarolic energy of the new vents. It is supposed that a large quantity of steam ejected from the new vents should be generated by the connection with ground water and demagnetized high temperature volcanic rocks around the remagnetization source. At Tsurumi-volcano, geomagnetic observation was started at the southern part of a small fumarole near the summit in December,1997.

For detection of volcanomagnetic effects, daily or annual geomagnetic changes must be eliminated from original data. Anomalous annual changes pointed out by JMA at Kijima survey point must be clarified. Although the origin will be caused by the magnetized pyroclastics ejected from Kijima volcano, as a first step four proton magnetometers set up to get the exact geomagnetic annual changes close to the survey point. A key depth to trench will be revealed by a time lag between the atmospheric temperature and anomalous geomagnetic change.

## Studies on electrical structure of the crust

***Tanaka, Y., Hashimoto, T., Masuda, H.**, Ogawa, Y.,*
*Takakura, S., **Amita, K. and Oba, S.***

In considering the volcanic formation, synthetic knowledge of seismic, geodetic, geologic and electromagnetic structures around a volcano is very important. In this view point the following researches are being performed.

1) Studies on electromagnetic structure of the crust in central Kyushu

This research has been performed in cooperation with the Geological Survey of Japan (GSJ). In this year, Very long-period (> 1000 seconds) magnetotelluric (MT) measure-ments aiming for the deep crustal structure were achieved at 6 sites on the northern part of Hita-Miyazaki survey line.

Broad-band magneto-telluric measurements were conducted at 16 sites across the Aso caldera along a NNE -SSW direction as a cooperative work with the GSJ. Preliminary analysis suggests that no conductive body corresponding to a magma reservoir has been found at the depth shallower than 10 km B.S.L. along the survey line of 1997 (Fig. 1).

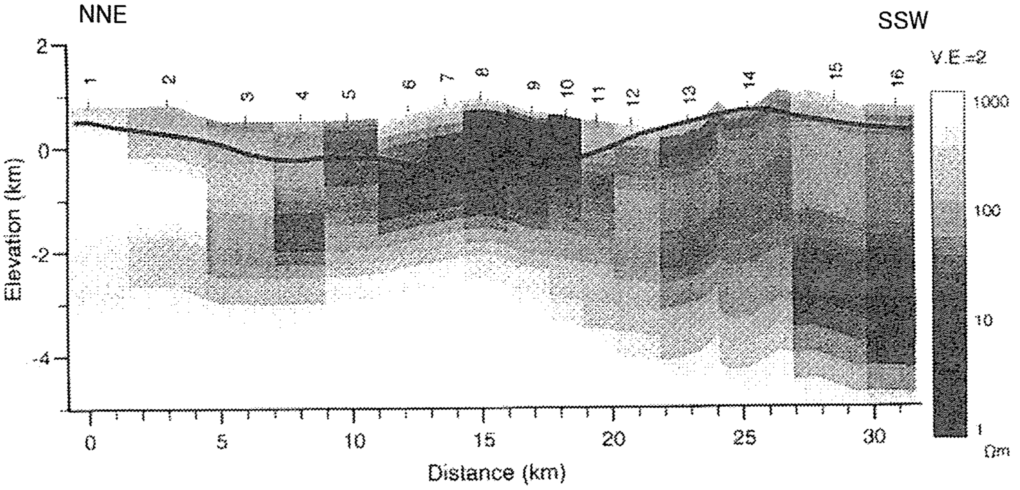



Fig. 1 Resistivity cross-section along the survey line. A solid line indicates the gravity basement (Komazawa, 1995). The figure was provided by S. Takakura of GSJ.

The network-MT surveys were also carried out in Ohita and Kumamoto prefectures in cooperation with Tokyo university. One of the important aims of this project is mapping the electrical conductivity of the crust and (hopefully) upper-mantle of the whole of Japan. The method employs metallic telephone lines for telluric measurements and hence has an advantage of long-spanned and two-dimensional coverage than in the case of standard type of MT. Measurement networks of 12 areas in Ohita pref. and 8 areas in Kumamoto prefs. (Fig. 2) were deployed in 1997.

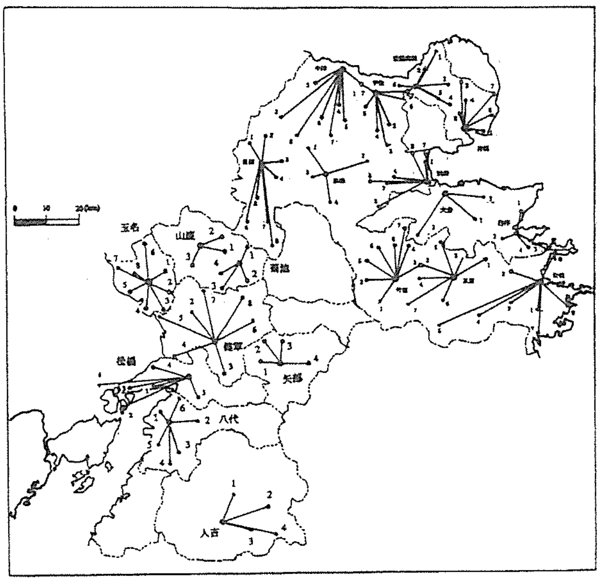


Fig. 2 Distribution of the telluric netwok in Ohita and Kumamoto prefs.

2) MT surveys in Indonesia

MT surveys in Indonesia were carried out to study tectonic setting around subduction zone. The surveys in central Jawa and southern part of Sumatra were performed in 1995, 1996 and in 1997, respectively, in cooperation with RDCG, LIPI and Kyushu university.

3) Study of electric structure beneath the sea off Kyushu

The electric conductivity of sea floor is sensitive in deep MT analysis of the land area in Kyushu, however the sub-marine data is lacking for this purpose. A use of retired submarine cable owned NTT was taken rather than sea floor EM system at the west part of Kyushu island in cooperation with Tokyo university and Politic college Kita-Kyushu. They were Fukue-Nagasaki, Fukuoka-Iki and Iki-Tushima. Preliminary results showed the electricity of the crust beneath the west part of Kyushu is highly conductive as supposed by westward induction vectors obtained by geomagnetic observations on the land.

### Development of exploration techniques and instruments

***Tanaka, Y.**, Mogi, T. and **Oba, S.***

*Declination magnetometer*

Magnetic changes originated in depths is smaller than 1nT and popular proton magnetometers are no more useful. The fluxgate type magnetometer is more effective in this case. It is somewhat expensive and unstable, however. Declination magnetometers were newly improved for volcanomagnetism and put to the test around active crater of Aso volcano.

*Aero-electromagnetic survey*

An aero-electromagnetic survey was performed at Unzen volcano in 1994 by us. Although information of deep subsurface was not obtained, it was very fascinating in quickness, easiness of wide region and uniformity. A ground source aero-magnetotelluric method was proposed by Dr.Mogi, Kyushu university, and high-quality fluxgate magnetometer system with sensitive gyrocompass and high-quality proton magnetometer were developed in cooperation with Dr. Mogi and T.Jomori, Morikawa and Kusunoki, by support of three years Monbusyo fund. A test flight was performed around Mt.Garan-dake, Beppu.

### Studies on electromagnetic signals associated with earthquakes

***Tanaka, Y.**, Mogi, T. and Hase, H.*

Varotsos et al., developped an earthquake prediction method using electrical signals in Greece. Although our stance is that the magnitude of the earthquake is decided after the initial outbreak, we agree the verification of SES in cooperation with Riken and Tokai university.

1) Telluric current observation in Liwa district in Indonesia

Self-potential observation with twin dipoles were started at five sites around active Sumatra fault, and some co-seismic telluric signals were observed associated with local earthquakes (M>5).

2) Telluric current observations in Kuju geothermal area and Minou fault

Former system is same as Indonesia. Even in central Kyushu, the electric field was contaminated by artificial noises caused mainly by electric railway in day time. Development of noise reduction method is necessary to detect SES signals in the data. The latter system was framed with unused commercial power line to avoid the cross-talk which occurrs on telephone lines. This line is set across the active Minou fault. We expect to get some SP signals or resistivity changes associated with the global stress changes.

3) Development of measuring system for spherics

Dr. Sighn of Indian Institute of Geomagnetism believes the enhancement of spherics before large earthquakes and want to develop an earthquake prediction system. Although the measuring system for spherics was developed with our help, it will not be useful for earthquake prediction because too many thunder storms occurred simultaneously in the world and the source can not discriminate each other.

# The petrology of a melilite-olivine nephelinite from Hamada, SW Japan

*Tatsumi, Y., Arai, R., and Ishizaka, K.*

A melilite-olivine nephelinite lava flow occurring in Hamada, SW Japan, is the most silica-undersaturated lava to erupt in Japan ($SiO_2$ content ~ 37 wt.%), and may be a least-fractionated melt from mantle depths. The heterogeneity of elements such as Si, Al, Ca, and alkaline elements is one of the characteristic features in the Hamada nephelinites and is likely to be attributed to hydrothermal alteration, because such element concentrations are correlated with $H_2O$ contents. Melting phase relations at high pressures on a least altered nephelinite sample in the presence both of $H_2O$ and $CO_2$ demonstrated that the nephelinite melt is multiply saturated with olivine and clinopyroxene but not with orthopyroxene, suggesting that the nephelinite magma was not derived from a lherzolite source, but possibly from a wehrlite source. Such an unusual mantle material may have been formed by carbonate metasomatism of a lherzolitic upper mantle, which is a process consistent with the geochemical characteristics of the Hamada nephelinite lava.
(submitted to J. Petrology)

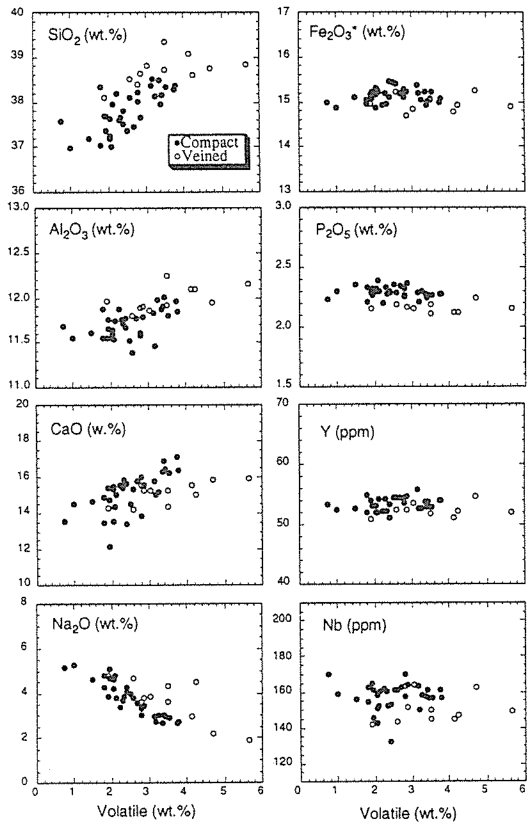



Fig. 1. Selected plots of volatile contents *vs.* major & trace elements. Plotted data are reculculated to be 100% total.

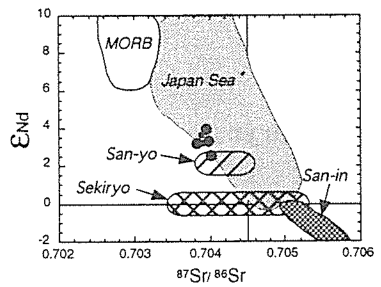



Fig. 2. Sr-Nd isotope compositions of Hamada nephelinites and Ceneozoic alkaline basalts in the Chugoku district after Kagami & Genbudo Research Group (1990).

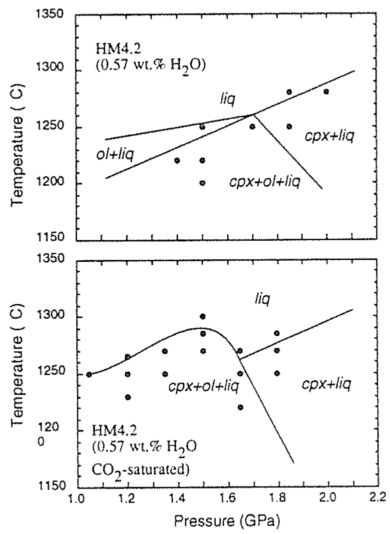



Fig. 3. Melting phase relations for a Hamada nephelinite, HM4.2, in the presence of $H_2O$ and $CO_2$.

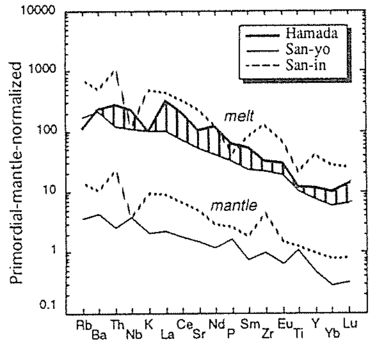



Fig. 4. Primordial mantle (Sun & McDonough, 1989) normalized element patters for Hamada nephelinite, 0.1% partial melts and mantle source in the San-yo and San-in regions. The difference between Hamada and San-yo melts (hatched) may be interspreted as the result of carboninite metasomatism for the Hamada source.

## Quantitative determination of gold and the platinum -group elements in geological samples using improved NiS fire assay and tellurium coprecipitation with Inductively coupled plasma - mass spectrometry (ICP-MS)

*Ohguri, K., Shimoda, G. and* ***Tatsumi, Y.***

New fire-assay and tellurium coprecipitation methods are developed for precise determination of Ru, Rh, Pd, Ir, Pt, and Au in geological samples by using ICP-MS. Fusion was repeated for two times a sample, and was carried out under reduced conditions. Te-coprecipitation was aslo operated two times a sample in consideration of heating temperature and time. These improvements offered near-quantitative recoveries for most elements (>90% for worst element) as a result of applying this procedure to some reference materials SARM-7, MINTEK2/77, WPR-1, UMT-1, and WMG-1. Total blanks were less than 42pg per 1g sample except for Ru and Au, and detection limits were within 2-53ppt (rock) for all elements. The present procedures can be applied to wide range of concentrations with high precision and reproductivity without losing simplicity compared with traditional method.
(submitted to Chem. Geol.)

Table 1 Analytical results (ppb) of PGEs for reference materials MINTEK2/77, WPR-1, UMT-1, and WMG-1

| Element | Number | Measured | RSD(%) | Ref. |
|---|---|---|---|---|
| *MINTEK 2/77* | | | | |
| Ru | 5 | 957.8 | 4.0 | 1020±100 |
| Rh | 5 | 507.8 | 2.7 | 520±80 |
| Pd | 5 | 1449.7 | 7.7 | 1590±190 |
| Ir | 5 | 205.5 | 4.1 | 180±40 |
| Pt | 5 | 2905.2 | 3.7 | 3110±140 |
| Au | 5 | 20.7 | 3.2 | 20 |
| *WPR-1* | | | | |
| Ru | 5 | 19.1 | 3.5 | 22±4 |
| Rh | 5 | 12.2 | 4.4 | 13.4±0.9 |
| Pd | 5 | 208.7 | 3.4 | 235±9 |
| Ir | 5 | 15.3 | 2.1 | 13.5±1.8 |
| Pt | 5 | 273.0 | 2.8 | 285±12 |
| Au | 5 | 41.8 | 5.8 | 42±3 |
| *UMT-1* | | | | |
| Ru | 5 | 8.7 | 8.8 | 10.9±1.5 |
| Rh | 5 | 8.8 | 4.0 | 9.5±1.1 |
| Pd | 5 | 95.6 | 3.9 | 106±3 |
| Ir | 5 | 10.0 | 7.9 | 8.8±0.6 |
| Pt | 5 | 132.0 | 6.8 | 129±5 |
| Au | 5 | 50.5 | 3.6 | 48±2 |
| *WMG-1* | | | | |
| Ru | 5 | 30.8 | 3.1 | 35±5 |
| Rh | 5 | 26.9 | 1.4 | 26±2 |
| Pd | 5 | 394.8 | 2.8 | 382±13 |
| Ir | 5 | 51.6 | 1.7 | 46±4 |
| Pt | 5 | 735.5 | 2.0 | 731±35 |
| Au | 5 | 108.7 | 6.8 | 110±11 |

RSD (%), relative standard deviation to average value
Ref., reference value

## Polynesian mantle plume from the core-mantle boundary: evidence from noble metal elements geochemistry

***Tatsumi, Y.****, Ohguri, K., Shimoda, G. and Barsczus, H.G.*

The source of a mantle plume has been believed to underlie the Earth's lithosphere. Such a deep plume thus offers opportunities for pursuit of the structure and evolution of the interior of the Earth. Polynesian hotspots in the South Pacific are characteristic both in the occurrence of HIMU basalts with extremely high lead isotope ratios and the presence of whole-mantle-scale low-velocity anomaly beneath the region, suggesting the upwelling of chemically distinct and very deep mantle plume. The first complete data set of platinum group elements (PGEs) and Au abundance in Polynesian hotspot lavas shows higher concentrations of such elements in the HIMU than the normal, non-HIMU reservoirs, providing new evidence for the

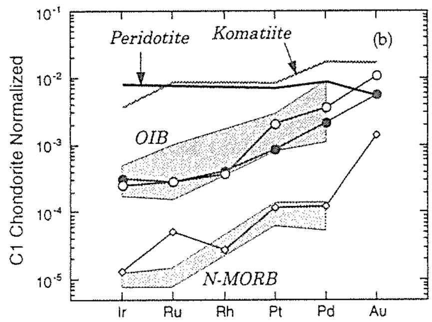



Fig. 1 PGEs spidergrams for terrestrial lavas, peridotites and average HIMU, non-HIMU and MORBs.

location of the Polynesian HIMU source at the base of the mantle where such elements may be added from the metallic core to the silicate mantle through core-mantle interaction.
(submitted to Nature)

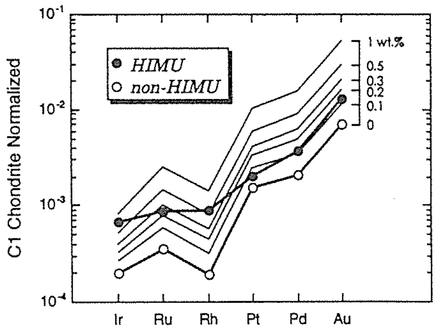



Fig. 3 Noble metal concentrations in partial melts from a hypothetical mantle source, which is produced by addition of outer core materials to an inferred primitive mantle of the source of non-HIMU magmas. The involvement of <1 wt.% core materials could explain compositions of PGE-enriched HIMU magmas.

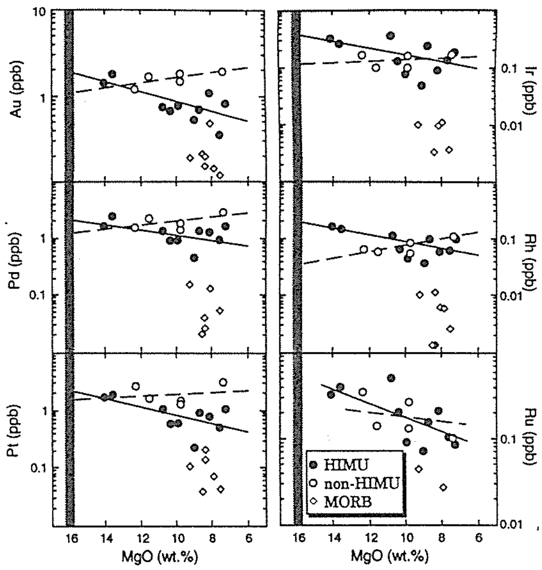



Fig. 2 MgO-PGEs variations for HIMU, non-HIMU and MORBs. HIMU and non-HIMU OIBs show different slopes with increasing degrees of magma differentiation, suggesting S-saturation and -undersaturation for these magmas, respectively. An important conclusion derived from these variations is higher concentrations of noble metal elements in HIMU than non-HIMU primary magmas with ~16 wt.% MgO.

## Setouchi high-Mg andesites revisited: geochemical evidence for melting of subducting sediments

*Shimoda, G., **Tatsumi, Y.**, Nohda, S., Ishizaka, K., and Jahn, B.M.*

In order to evaluate the mechanism of production of unusual high-Mg andesite (HMA) magmas, Pb-Nd-Sr isotopic compositions were determined for HMAs and basalts from the Miocene Setouchi volcanic belt in the SW Japan arc. The isotopic compositions of Setouchi rocks form mixing lines between local oceanic sediments and Japan Sea backarc basin basalts, suggesting a significant contribution of the subducting sediment component to the HMA magma generation. Mixing calculations using compositions of an inferred original mantle and local oceanic sediments suggest that a sediment-derived melt, neither an $H_2O$-rich fluid nor an amphibolite/eclogite-derived melt, could have been produced first and served as a plausible metasomatic agent for the HMA magma source. The unusual tectonic setting, including subduction of a newly-borne hence hot plate, may be responsible for melting of subducting sediments.

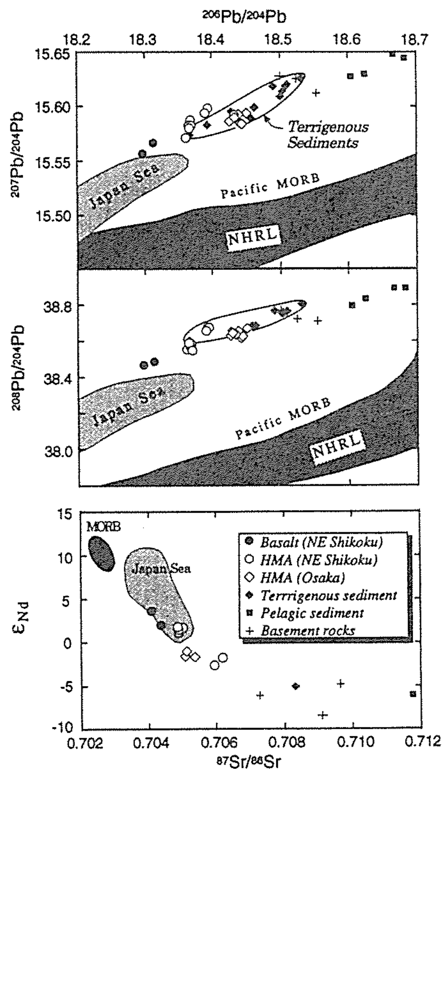



Fig.1 Pb, Sr, Nd isotope compositions of Setouchi and oceanic samples. Pb isotope compositions of Setouchi HMAs overlap those of terrigenous sediments from the Shikoku Basin, supporting the mechanism including transportation of subduction components with slab-melts rather than hydrous fluids.

A plausible process of production of HMA magmas in the Setouchi volcanic belt, SW Japan, which is consistent with unusual tectonic settings, melting phase relations of HMAs and isotopic/trace element compositions of HMAs and coeval basalts, is initial melting of subducting sediments on the young lithosphere, subsequent reactions of those hydrous silicic melts with overlying mantle peridotites, and final equilibration of a rising melt with uppermost mantle materials. Although the nature of Archean plate tectonics is uncertain, HMAs may have been more commonly produced in the Archean than at present simply due to possible slab melting associated with higher temperature distributions both in the subducting lithosphere itself and upper mantle. As Setouchi HMAs have compositions similar to igneous rocks that form a recognizable part of the continental crust [6,7], major parts of Archean dacites or tonalites, which are more common than andesites, may have formed by differentiation of Setouchi-type HMA (sanukitoid) magmas.
(Earth Planet Sci. Lett., in press)

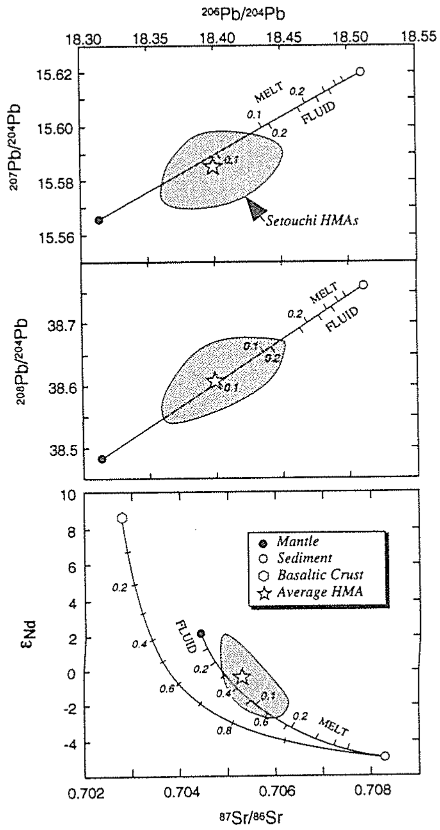



Fig. 2 Results of mixing calculations. Isotope compositions of Setouchi HMAs can be explained by addition of several percents of sediment melts to an inferred original mantle, not by fluid addition. Involvement of basaltic crust in forming slab-derived component may not be likely, because such slab components are more depleted than expected.

## Generation of rhyolite magmas by melting of subducting sediments in Shodo-shima Island, SW Japan, and its bearing on the origin of high-Mg andesites

*Tatsumi, Y. and Shimoda, G.*

Geochemical characteristics of rhyolites from the Miocene Setouchi volcanic belt in the SW Japan arc were examined. The following observations may be best explained by derivation of rhyolite magmas by melting of subducting sediments: (1) Sr-Nd-Pb isotope compositions of Setouchi rhyolites are well within the range of those of the local trench-fill sediments; (2) major element compositions of rhyolites are close to those of experimentally-produced sediment melts; (3) high Sr/Y ratios in rhyolites (*ca.* 30) are consistent with the presence of garnet and the absence of plagioclase in the melting residue, suggesting melting of subducting, not intra-crustal sediments. Furthermore, trace element and isotope signatures of Setouchi high-Mg andesites can be also elucidated by interaction of such rhyolitic sediment melts with overlying mantle peridotites.

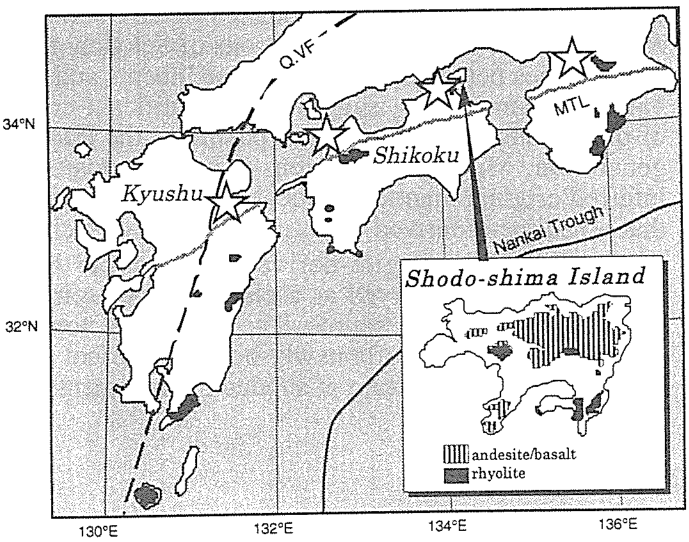



Fig. 1 Location of Miocene Setouchi volcanic rocks (stars) and felsic rocks (filled) in the SW Japan arc. In the Shodo-shima Island, are distributed collectively Setouchi volcanic rocks including rhyolites, high-Mg andesites, calc-alkaline andesites, and basalts.

Rising such rhyolitic sediment melts react with the overlying mantle to form HMA and finally basalt magmas with more olivine-component-enriched, hornblende-component-depleted, and depleted isotope compositions. The Setouchi volcanic belt was built under anomalously high temperature conditions in associated with subduction of newly-borne, hence hot plate into the hot mantle caused by spreading of the Japan Sea backarc basin. Generation of felsic and HMA magmas by melting of subducting sediments may thus be an important mechanism for Archean magma genesis and crustal formation due to higher temperature distributions both in the subducting lithosphere itself and upper mantle than the present Earth.

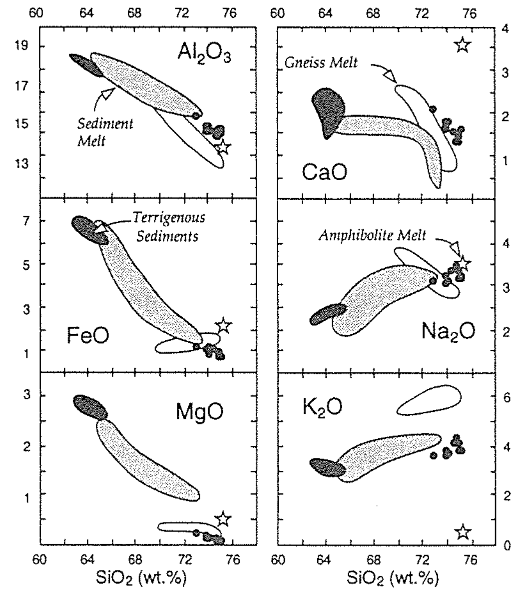



Fig. 3 Major element compositions of Setouchi rhyolites, experimentally determined sediment/amphibolite/gneiss melts, and terrigenous sediments in the Nankai Trough subduction zone.

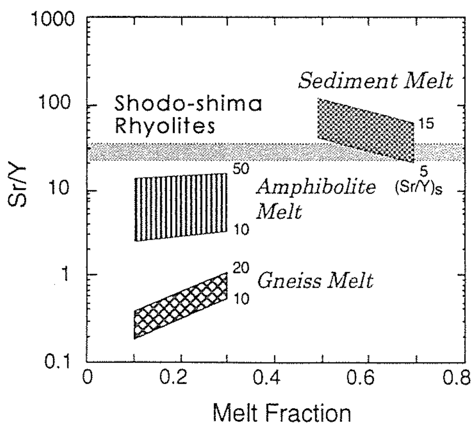



Fig. 4 Sr/Y ratios in Setouchi rhyolites and inferred partial melts from sediments, amphibolites and gneiss. Compositions of Setouchi rhyolites are best explained by melting of subducting sediments in the presence of residual garnet.

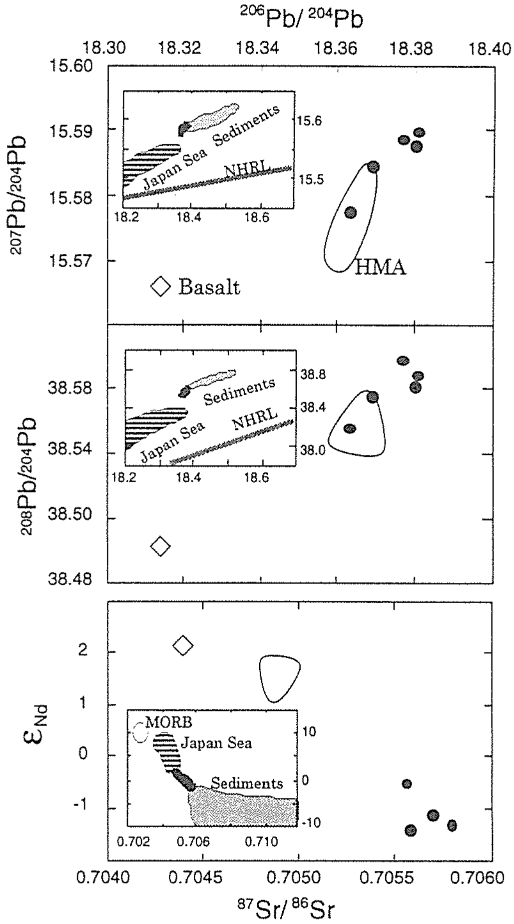



Fig. 2 Isotope compositions of Setouchi rhyolites, high-Mg andesites (HMA) and basalts.

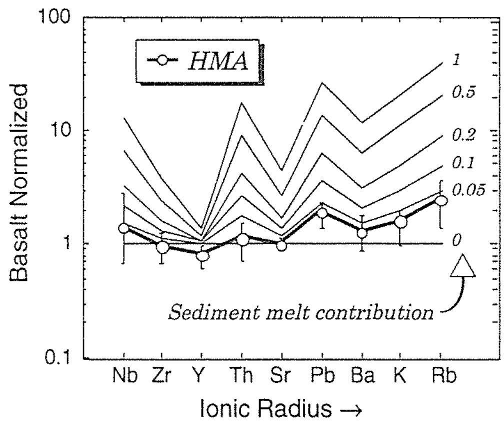



Fig. 5 Trace element modeling for sediment melt -mantle reactions. HMA compositions can be produced by several percents of sediment melt involvement in forming the magma source.

## An investigation of seismicity in and around Kuju volcano

*Tsutsui, T. and Sudo, Y.*

This investigation aim to declear undergraound volcanic activities through the data obtained with the seismic network. A major task in 1997 was classify seismic events associating with evidences of volcanic activity. We achieved that the tremor, so-called "USS-LF" type, is a sort of low frequency earthquake which have been reported in other volcanic area.

## Seismic survey and investigations of subsurface structure of the volcanoes by means of controlled source

*Tsutsui, T., Sudo, Y., Mori, T., Nakaboh, M.,*
*a group for controlled sourceseismics in Unzen volcano,*
*a group for controlled source seismics in Kirishima volcano, and*
*a group for controlled source seismics in Bandai volcano*

Controlled source seismic surveys have been carried out in four times for three volcanoes, Kirishima, Unzen, Bandai, since 1994. We have joined and cooperated to obtain and processing data in every projects. Bandai volcano was the target of th project and data acquisition and processings were carried out this year.

Here also later phases is a target of interest. Later phases contains various information of deeper part than first arrival in volcano. T. TSUTSUI have processed the later phase obtained in the project Unzen and the paper on this topic is under production. Data obtained in the project Bandai also contains some clear later phases and these are also a target of an investigation. Processing have been continued in next year.

Moreover, a preparation for a new experiment was made in this year. the project Aso will be carried out in 1998. Some theoretical considerations on its field design were made with simulation of the wave field in inhomogenious medium.

**Continuous recording of gravity using a superconducting gravimeter (SG) near the active crater of Aso Volcano**

*Yoshikawa, S., Mori, T., Nakaboh, M., Sudo, Y., Tsutsui, T., Masuda, H., Hoka, T., Sako, M., Yamada, T., Tanaka, M., Ono, H., Kikuchi, S. and Hashimoto, T.*

Near the active crater of Aso Volcano, SG was installed in 1994. We have been troubled about the continuous observation. From the end of 1996, we could acquired the continuous data. We now expect the good correlation between the volcanic activity and the change of gravity.

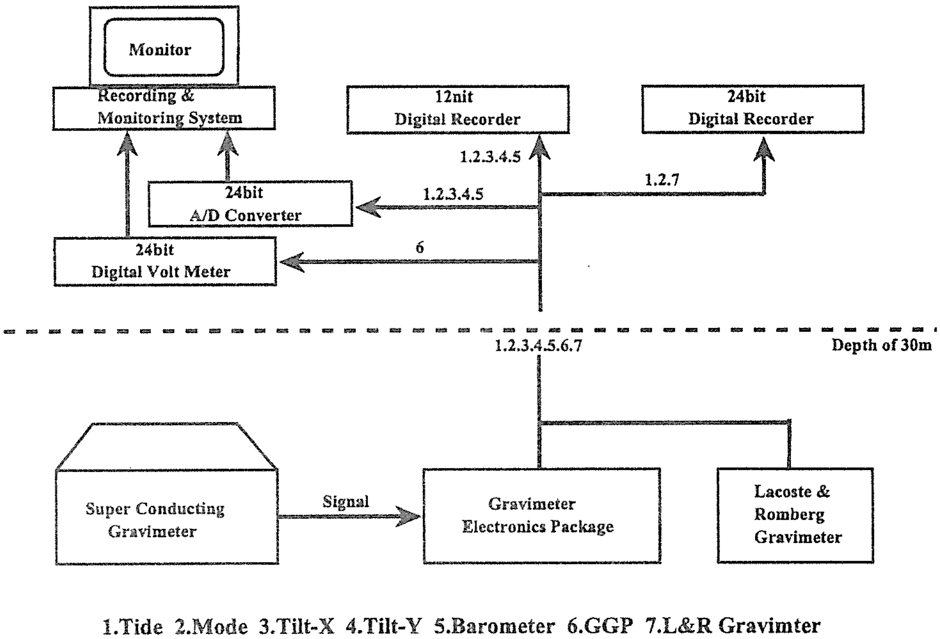



Fig.1 Recording system of super conducting gravimeter at Hondo observatory.

**Temperature observation at the 1st crater of Aso Volcano**

*Yoshikawa, S., Mori, T., Sudo, Y., Hoka, T., Masuda, H., Yamada, T., Sako, M., Kikuchi, S., Ono, H., Hashimoto, T., Nakaboh, M. and Tanaka, M.*

The 1st crater of Aso Volcano has a crater lake which has survived since 1993 to 1998. During this period Aso Volcano experienced some mud eruptions in 1994. In 1996 the south wall of the crater was heated to red. No prominent surface activity has not been seen after that. We began to measure the temperature of the crater lake and of the fumarolic area of the south wall since August in 1996. Measurements were repeatedly made with an infrared radiation thermometer at a fixed point located 150m southwest of the center of the 1st crater, under which a video camera was installed by Aso Volcano Museum for monitoring the activity. The following observations are reported.

1) The crater lake gets hotter and the fumarolic area gets cooler towards the summer season.
2) The crater lake gets cooler and the fumarolic area gets hotter towards the winter season.
3) The temperatures of the two are in anti-phase for the periods shorter than 1 year.
4) Both crater lake and fumaroles are slightly cooling down in long term.

These results lead us to the following hypothesis. The surface of the crater lake gets warmer as a result of temperature increase of the atmosphere towards summer. On the other hand the fumaroles tend to be cooled down by the increase of precipitation in the season. In contrast, the lake surface gets cooler as a result of the temperature decrease of the atmosphere towards winter. And the fumaroles get hotter because they tend to come out without cooling by rain water in the dry season. Aso volcano has been in a calm state for recent four years, and hence, the results presented above are those of a quasi-steady state. It is still unknown how the temperature will change when the volcano gets to be more active. It is also important to collect the data during the active state for understanding the thermal system below the crater lake.

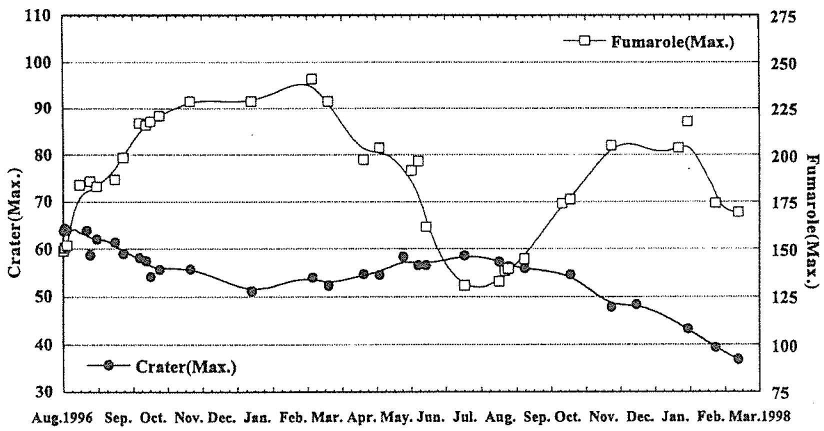



Fig.1 Temperature changes at the 1st crater of Aso Nakadake volcano measured by IRT. Open rectangles denote the maximum temperature of fumarolic area. Filled circles indicate the maximum temperature of the crater lake.

# A brief report on the activities of Aso and Kuju volcano in 1997
# and
# routine observations of AVL

## Purpose of routine observations

A major activity of AVL is research for volcanoes through geophysical approaches. Geophysical approaches enables us to monitor a status of a volcanic activity at a present. We intend to make clear dynamic mechanisms of volcanic activities through these observations.

In order to recognize volcanic processes exactly, it is nesessory to have data not only on the active state but also the quiet state through continuous routine observations. These data enables us to define present status of the activity and forecasting forthcoming state of the volcano exactly. Occurence of individual phenomena is not able to be forcasted and data already obtained have a potential to be a great discovery which can achieve an great advance in volcanology. Then data obtained with routinely observations are very important resource and can be a start point of our volcanological study.

We have defined that our routine observation is very important facility and our foundation of research. All AVL staffs spends most of their official time to support routine observation under the concept described above.

## Routine observation crew

< Research staffs>

*Yasuaki SUDO, Shigetomo KIKUCHI, Hiroyasu ONO, Tomoki TSUTSUI, Takeshi HASHIMOTO, and Yoshikazu TANAKA.*

<Technical staffs>

*Teruaki HOKA, Toshihiro YAMADA, Hideharu MASUDA, Mikio SAKO, and Shin YOSHIKAWA*

<Postgraduate course students>

*Takehiko MORI, Makoto NAKABOH, Maki TANAKA, and Miyuki YOSHIKAWA*

## Functions of routine observations

<Seismology>

A control of the broad area network; *Y. SUDO*
Analysis with the broad area network; *Y. SUDO*
A control of the summit network in Aso; *H. ONO*
Analysis with the summit network in Aso; *H. ONO and T. MORI*
Maintenance works on instruments;
*T. HOKA, M. SAKO, H. MASUDA, T. YAMADA, and S. YOSHIKAW,*
Maintenance works on the field;
*T. HOKA, M. SAKO, H. MASUDA, T. YAMADA, and S. YOSHIKAWA*
Maintenance works in Kuju seismic network;
*T. TSUTSUI, T. HOKA, H. MASUDA, and S. YOSHIKAWA*
Analysis with Kuju seismic network;
*T. TSUTSUI, M. TANAKA, and M. YOSHIKAWA*
Volcanic tremor accumulator; *Y. SUDO and M. SAKO*

<Ground deformation>

Tiltmeters and extensiometers in Aso; *S. KIKUCHI and M. SAKO*
Tiltmeters in Kuju; *M. SAKO*
GPS and EDM in Aso; *H. ONO, and M. SAKO*
EDM in Kuju; *H. ONO, M. SAKO, and M. NAKABOH*
GPS in Kuju; *H. ONO and S. KIKUCHI*
Leveling survey in Aso; *M. NAKABOH and all*
Super conductivity gravitymeter; *Y. SUDO, S. YOSHIKAWA, and T. MORI*

<Geomagnetism>

Fulltime monitoring of total force in Aso; *T. HASHIMOTO*
Fulltime monitoring of total force in Kuju; *Y. TANAKA*

Self-potential observation in Kuju; *T. HASHIMOTO and H. MASUDA*

<Miscellaneous>

Geothermal observation by the active crater in Aso; *Y. SUDO and M. SAKO*

Visual monitoring of the new vents in Kuju; *Y. SUDO and M. NAKABOH*

## Aso volcano in 1997

*The active crater;*

Recent and historical activity of Aso concentrates in the summit crators. The first crater, northmost one, is the only active vent recent years. A small activity since January 1992 lasted until January 1993. The activity level decayed after a stromborian eruption on late January 1993. After the activity decreaced a water pool have come out on the bottom of the first crater on February 1993 and been growing into full covarage of the bottom.

The water pool looks greenish gray and slow convection in it. On the otherhand, adjacent area of this water pool remained still active. Incandescence were observed on the lower level of the southern wall on April 1996 and a small new vent came out by the pool on November 1997.

Volcanic earthquakes;

About two events which can be determined their hypocenters are occur for a month around the summit area of Aso volcano, including monthes without such events. November 1997 was a particular month which includes determined six hypocenters, which is more than the average occurence of the events.

*Volcanic tremor;*

Average amplitude decreased until June 1997 after the peak on December 1996 and then had a minimum. Succeedingly, Average amplitude increased and reached a peak on late August 1997. And after the peak, average amplitude decreased and then kept in low level until next November. A coseismic enhancement was observed at the event on M4.3 beneath the western wall of the caldera on 12 November. High amplitude state have continued until late January 1998.

*Ground deformations;*

*- Tiltmeters -*

Though clear trend that indicate crater side subsidence have been observed since late 1995, No signal which implies subsurface volcanic activity can be seen during this period. Certain precipitation effects appeared during the rainy season, June to July.

*- Extentiometers -*

Extension appears over all components in our extentiometer. Movement became reverse except for the component E-2 (almost E-W direction).

Movement reverse appeared again on October 1997 and this pattern of the movement reverse are inferred as a part of an annual cycle.

*Geomagnetism;*

Variation of total intensity showed a plateau during early 1997. Total intensity began to increase after March 1997 which correspond to underground cooling down. This trend seems to have been acceralated since July 1997.

*Miscelaneous activity in the surrounding area;*

A large shock (M4.3) occured on 12 November 1997 whose hypocenter was determined just under the western rim of the caldera and many aftershocks were recorded during the following week. An estimated distribution of the aftershocks delineates from Northeast to Southwest direction and the mechanism solution was interpreted as right lateral strike-slip type with considering the pattern of the aftershock distribution.

Some grave stone relocations and damages was observed over Tateno and kurokawa area, Choyo-son. A dameged roofing was observed in Tateno area. AVL building is included in this area but damege was not serious.

*Volcanic disasters and incidents;*

Two tourists were killed on the craterside with asthema fit which triggered by breathing sulpher dioxiside rich volcanic gas on 23 November, 1997.

**Kuju volcano in 1997**

*Activity of the 1995 new vents;*

These new vents, a2', eastern-"b", c, and d vent, emarged with the phreatic eruption on October 1995, are still active. The majority gas emission comes from "d-vent" and "c-vents". Volcanic gas is a major emittion from the vents and no ash eruption is reported in 1997.

*Seismic activity;*

An average seismicity obtained in and around Kuju volcano is about ten events for a day and they keep steady state. There are two major cluster of the seismicity, Iwoyama area and northwestern to north frank of the volcano. Hypocentral distributions are different between these area as the former activity concentrates above sea level and the latter one distributes above minus five killometer depth.

A swarm around Iwoyama area emarged within several hours on 12 November 1997, just before the mainshock of Aso caldera wall. There have been many swarms occured in northwestern to north frank of Kuju volcano and this period also includes such swarm activities as follows; 9 to 11 January, 27-28 May, and 3 September 1977.

*Ground deformation;*

*-EDM-*

Contraction associated with BM HSS is still going with some cyclic (seasonal?) disturbances. The rate of the contraction have been decreasing after a rapid contraction just after the first eruption.

*-GPS-*

No clear deformation is obserbed from GPS network except for the nearest BM of the new vents that have been indicated not systematic motion.

*-Tiltmeters-*

No clear tilting motion caused by volcanic activity is observed.

*Geomagnetism;*

Continuous increasing of the total intensity continues, which correspond to a constant cooling in the shalower part under the surface. The rate of the increasing is still constant and no obvious change is observed.

## 阿蘇火山および九重火山の火山活動状況(1997)と火山研究センターの定常観測

【定常観測の目的】

火山研究センターでは、火山を対象とした地球物理学的な手法による研究活動を行っている。火山研究センターの中心的な研究課題は、活動する火山の内部における現在の活動状態の推移を認識し、このような火山活動の変化が起きる機構を解明することである。

火山活動の状態の変化を検知し研究するためには、火山活動の最盛期のデータばかりではなく火山活動の平穏な時期のデータ（たとえば地震活動度や地磁気変化、傾斜変化など）を基礎量として変化の規模や方向を検討しなければならない。また火山活動に伴う個々の現象はその発生を予測することが困難であるとともに、すでに取得されたデータの中にも発見を待っている現象が潜んでいる可能性が秘められている。したがって定常観測から得られるデータは非常に重要なものであるうえ、このデータに立脚して演繹的に研究を発展させなければならない。

以上の理由から火山研究センターでは、定常観測によって得られたデータを研究の背景を構成するものであると同時に、火山の動的現象の研究の興味の中心となるものと位置づけたうえで、総力を挙げて定常観測の維持と運用に力を注いでいる。

【定常観測従事者一覧】

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須藤靖明、菊池茂智、小野博尉、筒井智樹、橋本武志、田中良和

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外　輝明、山田年広、増田秀晴、迫　幹雄、吉川　慎

<大学院生>

森　健彦、中坊　真、田中麻貴、吉川美由紀

【定常観測項目】

＜地震観測＞
広域地震観測網の統括（須藤）
広域地震観測網データの解析（須藤）
火口周辺観測網の統括（小野）
火口周辺観測網データの解析（小野・森）
地震観測計器維持保守（迫・外・増田・吉川・山田）
地震観測点維持（迫・外・増田・吉川慎・山田）
九重火山地震観測網の維持（筒井・外）
九重火山地震観測網データの解析（筒井・田中麻・吉川美）
阿蘇火山の火山性微動積算観測（須藤・迫）

＜地盤変動観測＞
阿蘇火山傾斜・伸縮観測（菊池・迫）
九重火山傾斜観測（迫）
阿蘇火山ＧＰＳ・辺長観測（迫・小野）
九重火山辺長観測（小野・迫・中坊）
九重火山ＧＰＳ観測（小野・菊池）
阿蘇火山水準測量（中坊ほか全員が支援）
超伝導重力計観測（須藤・吉川慎・森）

＜地磁気観測＞
阿蘇火山地磁気連続観測（橋本）
九重火山地磁気連続観測（田中良）
九重火山自然電位観測（橋本・増田）

＜その他＞
阿蘇火山における地温観測（須藤・迫）
可視画像による九重火山の活動状況観測（須藤・中坊）

【阿蘇火山】

＜中岳第一火口の状況＞
現在の阿蘇の活動の中心は火口列最北端の中岳第一火口である。1992年1月から始まった小活動は1993年1月にストロンボリ式噴火を行った後に衰えた。引き続いて1993年 2月より中岳第一火口底に出現した湯溜まりは、火口底全面を占める状況で存在し続けている。

火口底の湯溜まりは灰緑色を呈し、湯の流動は緩やかである。一方、湯溜まり周辺での活動は活発な状態で推移しており、1996年4月に火口南壁下部の噴気孔で赤熱現象が確認されたのに引き続き、1997年11月には湯溜まりに隣接して新たな土砂噴出孔の形成が確認された。

＜火山性地震＞
震源が決定できる地震は、平均して月に2回程度である。1997年2月、12月、1998年1月は震源決定ができる地震が観測されなかった。その中で1997年11月は平均回数を上回る6つの地震が震源決定された。

＜火山性微動＞
1996年12月に増大していた積算振幅が翌97年6月まで減少する傾向にあった。しかし、6月から8月下旬までの期間には再び積算振幅が増大し、8月下旬に極大となった。さらに、この後振幅が減少した状態が11月まで続いたが11月12日に発生したカルデラ西壁直下の地震活動と時を同じくして振幅が急増し、1998年1月下旬までこの状態を維持している。

＜地盤変動＞
＊傾斜計：大きな傾向として、火口側が沈下する傾動が1995年後半から現れ続けている。また、やはり梅雨期の降雨の影響が6月～7月にかけて認められる。シグナルと考えられ得る、記録上の目立った乱れはこの時期を通じて認められない。

＊伸縮計：1997年2月中旬まで3成分とも伸張傾向が見られていた。これ以降E-2（ほぼ東西）成分以外が

短縮傾向へと変化した。その後、1997年10月を境に3成分とも伸張の傾向が見られるようになったが、これは年周変化を示していると考えられる。

<地磁気変化>
火口近傍の4カ所に設置されたプロトン磁力計により地磁気全磁力を測定しており、磁場変化から火口直下の等価磁気ダイポールの消長をみることができる。阿蘇火山では熱消帯磁モデルを適用することで地下における加熱・冷却の状況を推定している。1997年に入って磁力変化は停滞する傾向にあったが、3月以降は地下での冷却による帯磁をしめすデータが得られている。また、7月以降には帯磁（冷却）の傾向がいっそう加速されたように見える。

<周辺の活動>
1997年11月12日にカルデラ西壁直下でM 4.3の地震が発生し、以後約1週間にわたって余震活動が続いた。余震は北東－南西方向に分布し、余震分布を考慮すると本震の震源解は右横ずれ型と推定された。火山研究センター周辺の長陽村立野地区、黒川地区では墓石の移動現象が観察され、立野地区では一軒の民家の屋根瓦に損害が出た。火山研究センター内部でも軽微な被害が発生した。

<火山災害>
1997年11月23日に阿蘇火口見物に訪れた観光客のうち2名が火山ガス中毒で犠牲となった。

【九重火山】

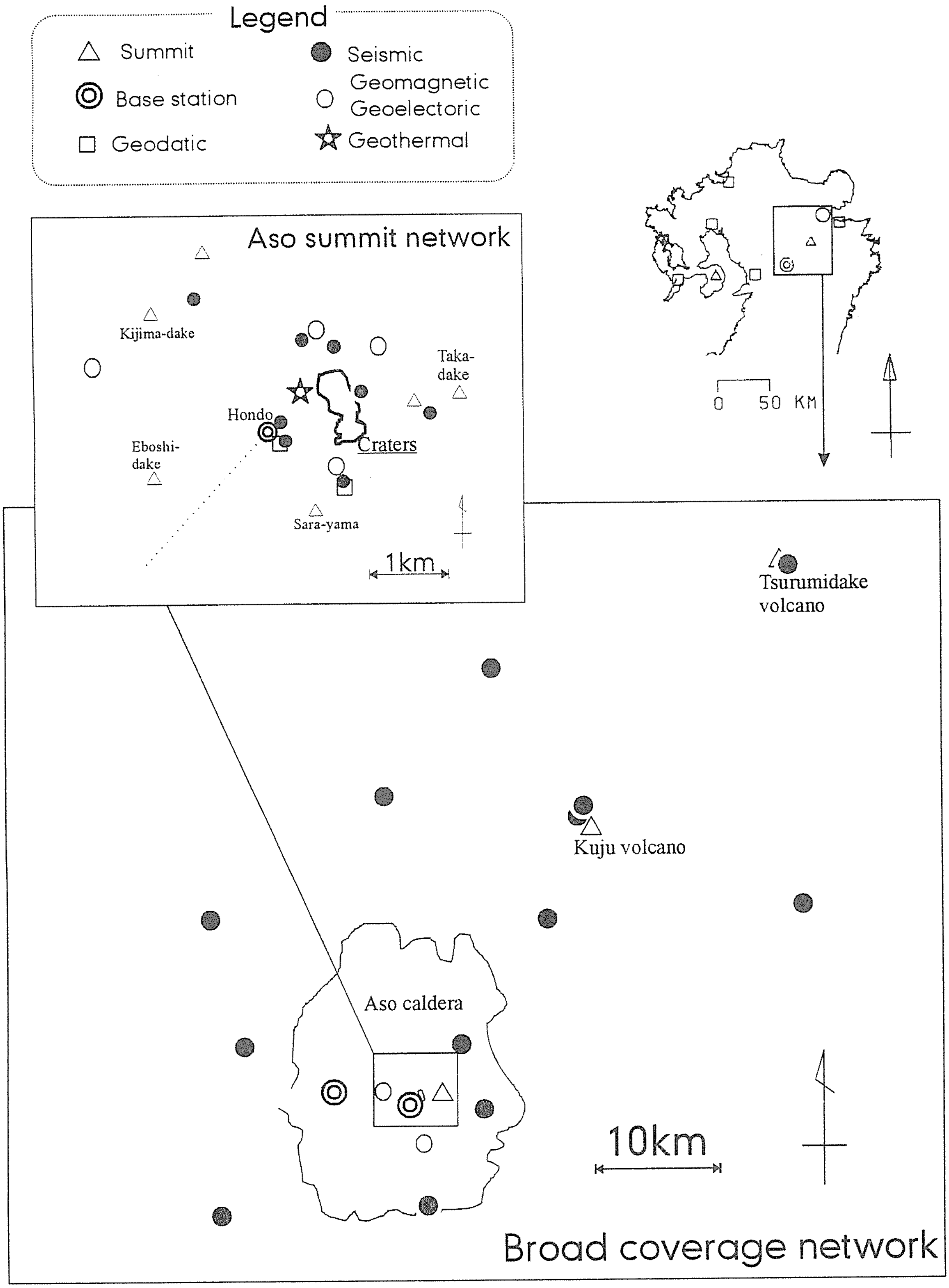
<1995年新火口の状況>
1995年10月に水蒸気爆発を伴って形成された　1995年新火口は依然として活発に噴気活動を継続している。新火口のうち、現在も活動を続けているのは a2' 火口、b 火口列東側のグループ、c 火口、d 火口であり、活動の中心となっているのは d 火口および c 火口列である。

<地震活動>
九重火山とその周辺で観測される地震の回数は平均して1日に10回弱であり、依然としてこの状態を継続している。おもな地震の発生場所は(1)通称硫黄山地区、(2)九重火山の北西～北山麓に大別される。前者は海水準以上に多くの震源が決定され、後者は海面下5キロ以浅に多くの震源が決定される。
1997年11月12日には硫黄山地区を震源とする微小地震が短時間に集中して発生した。
さらに、1997年1月9日～11日、5月27～28日、9月3日に北西～北山麓一帯を震源とする集中的な地震活動があった。

<地盤変動>
辺長測量：星生山基準点を含む測線で1995年の噴火活動開始直後に急激な短縮が観測されたが、これ以降短縮はその速度をゆるめながら継続している。観測開始以降、この大きな傾向は変わっていないが、数ヶ月周期の変動もこの中に含まれている。
ＧＰＳ測量：観測開始以来大きな変動は観測されて居らず、面積ひずみの変動量は$1\times10^{-6}$以下である。しかし、活動中の1995年新火口に最も近い基準点 (283) では相対的な変動量が目立って大きい。しかし、この変動量のパターンは複雑で系統的な傾向を見つけるのは困難である。
傾斜計観測：2つの観測点では特に大きな傾斜変動は観測されていない。

<地磁気観測>
地磁気測定からは地下浅部での冷却（＝帯磁）が進行していることが示唆されている。この帯磁の進行速度は1995年の観測開始以来ほぼ一定で、めだった変化は認められていない。

# AVL geophysical networks



# 公表論文　Publications

＜査読有＞


Aizawa, Y., Tatsumi, Y. and Yamada, H. (1998) Element transport by dehydration of subducted sediments: implication for arc and ocean island magmatism. The Island Arc, in press.

Electromagnetic Research Group for the 1995 Hyogo-ken Nanbu Earthquake (1997) Tectonoelectric Signal Related with the Occurrence of the 1995 Hyogo-ken Nanbu Earthquake (M7.2) and Preliminary Results of Electromagnetic Observation around the Focal Area. J. Phys. Earth, 45, 91-104.

Garces, M. A., Hagerty, M. T. and Schwartz, S. Y. (1998) Magma acoustics and time-varying melt properties at Arenal Volcano, Costa Rica. Geophys. Res. Lett., accepted.

Garces, M. A., Hansen, R. A. and Lindquist, K. G. (1998) Travel times for infrasonic waves propagating in a stratified atmosphere. Geophys. J. Int., accepted.

Handa, S., Suzuki, A. and Tanaka, Y. (1998) The electrical resistivity structure of the Aso caldera, Japan. Bull. Volcanol. Soc. Japan, 43, 15-23.

Hashimoto, T. (1997) Self-Potential Changes and Subsurface Hydrothermal Activity Accompanying the 1990-1995 Eruption of Unzen Volcano. J. Geomag. Geoelectr., 48, 1219-1232.

波多江憲治・渡辺公一郎・渡辺一徳・筒井智樹・本村慶信 (1997) 九重火山1995-96噴火活動に伴う火山灰中の発泡ガラス含有量の経時変化．火山，42, 345-353.

鍵山恒臣・歌田久司・三ヶ田均・筒井智樹・増谷文雄 (1997) 霧島火山群の構造とマグマ供給系．火山，42, S157-S166.

小林正雄・北岡豪一・吉岡龍馬・堀内公子・笹井恵美 (1997) 比叡山地東麓一帯の降水・河川水および地下水の水素・酸素の同位体比．日本水文科学会誌，27, 143-150.

Kogiso, T., Tatsumi, Y. and Nakano, S. (1997) Trace element transport during dehydration processes in the subducted oceanic crust: 1, experiments and implications for the origin of ocean island basalts. Earth Planet. Sci. Lett., 148, 193-205.

Kogiso, T, Tatsumi, Y., Shimoda, H. and Barsczus, H.G. (1997) HIMU ocean island basalts in southern Polynesia: new evidence for whole-mantle scale recycling of subducted oceanic crust. J. Geophys. Res., 102, 8085-8103.

Kusumoto, S., Fukuda, Y., Takemoto, S. and Yusa, Y. (1997) Interpretation of gravity low in and around Beppu Bay, Kyushu, Japan. Int. Assoc. Geodesy Symposia, 117, 320-327.

大沢信二・由佐悠紀・北岡豪一 (1997) 九重硫黄山の噴気地域から放出される塩化水素・マグマ性水蒸気量の推定．日本地熱学会誌，19, 73-83.

大沢信二・由佐悠紀・大上和敏・北岡豪一 (1997) 阿蘇火山地域から放出される噴気ガスの不活性ガス組成．温泉科学，47, 56-67.

Oshiman, N., Sasai, Y., Honkura, Y., Ishikawa, Y. and Tanaka, Y. (1997) Geomagnetic changes correlated with crustal movement in the north-eastern part of the Izu peninsula, Japan. Annali di Geofisica, XL, 479-494.

大上和敏・大沢信二・中川理恵子・高松信樹・由佐悠紀（1997）別府血の池地獄の色彩変化に関わる沈殿物の鉱物組成・温泉水の化学組成の変化．温泉科学，47，56-67.

Shimoizumi, M., Mogi, T., Nakada, M., Yukutake, T., Handa, S., Tanaka, Y. and Utada, H. (1997) Elecrical conductivity anomalies beneath the western sea of Kyushu, Japan. Geophys. Res. Letter, 24, 1551-1554.

Sumitomo, N. et al. (1997) Electromagnetic Research Group for the 1995 Hyogo-ken Nanbu Earthquake, Tectonoelectric Signal Related with the Occurrence of the 1995 Hyogo-ken Nanbu Earthquake (M7.2) and Preliminary Results of Electromagnetic Observation around the Focal Area. J. Phys. Earth, 45, 91-104.

Sasai., Y., Zlotnicki, J., Nishida, Y., Yvetot, P., Morat, P., Murakami, H., Tanaka, Y., Ishikawa, Y., Koyama, S. and Sekiguchi, W. (1997) Electromagnetic monitoring of Miyake-jima volcano, Izu-Bonin arc, Japan: a preliminary report. J. Geomag. Geoelectr., 49, 1293-1316.

Shimoda, G., Tatsumi, Y., Nohda, S., Ishizaka, K. and Jahn, B.M. (1998) Setouchi high-Mg andesites revisited: geochemical evidence for melting of subducting sediments. Earth Planet. Sci. Lett., in press.

須藤靖明（1997）九重火山の活動と噴火予知，火山，42，75-81.

Sudo, Y. and Hurst, A. W. (1998) Temperature changes at depths to 150 metres near the active crater of Aso Volcano: preliminary analysis of seasonal and volcanic effects. J. Volcanol. Geotherm. Res., 81, 159-172.

Sudo, Y., Ono, H., Hurst, A. W., Tsutsui, T., Mori, T., Nakaboh, N., Matsumoto, Y., Sako, M., Yoshikawa, S., Tanaka, M., Kobayashi, Y., Hashimoto, T., Hoka, T., Yamada, T., Masuda, H. and Kikuchi, S. (1998) Seismic

activity and ground deformation associated with 1995 phreatic eruption of Kuju Volcano, Kyushu, Japan. J. Volcanol. Geotherm. Res., 81, 245-267.
巽好幸（1997）地殻の成り立ちとマグマプロセス．岩波講座地球惑星科学８，地殻の形成，岩波書店，東京，49-70.
巽好幸（1997）マントルダイナミクスⅣ－進化．岩波講座地球惑星科学10，地球内部ダイナミクス，岩波書店，東京，201-229.
Tatsumi, Y. and Kogiso, T. (1997) Trace element transport during dehydration processes in the subducted oceanic crust: 2, origin of chemcial and physical characteristics in arc magmatism. Earth Planet. Sci. Lett., 148, 207-221.
Tatsumi, Y., Arai, R. and Kogiso, T. (1997) Subduction zone magmatism at depths to 2900 km: an overview. Bull. Volcanol. Soc. Japan, s219-s230.
Tatsumi, Y., Shinjoe, H., Ishizuka, H., Sager, W.W. and Klaus, A. (1998) Geochemical evidence for a mid-Cretaceous superplume. Geology, 26, 151-154.
筒井智樹・鍵山恒臣・三ヶ田均・他６６名（1996）人工地震探査による霧島火山群の地震波速度構造　－はぎ取り法による解析－．火山, 41, 227-241.
筒井智樹・須藤靖明・吉川　慎・井川　猛・黒田　徹（1997）阿蘇カルデラ南郷谷における反射法地震探査．火山, 42, 257-268.
Vanyan, L. L., Utada, H., Shimizu, H., Tanaka, Y., Palshin, N. A., Stepanov, V., Kouznetsov, V., Medzhitov, R. D. and Nozdrina, A. (1998) Studies on the lithosphere and the water transport by using the Japan Sea submarine cable (JASC):1. Theoretical considerations. E.P.S, 50, 35-42.

＜査読無＞

火山研究センター

火山噴火予知連絡会会報

九重火山の火山活動について（1996年9月～1997年1月）. 67, 37-51, 1997
阿蘇火山の最近の活動（1996年9月～1997年1月）. 67, 59-62, 1997
九重火山の火山活動について（1997年1月～5月）. 68, 61-68, 1997
阿蘇火山の最近の活動（1997年1月～5月）. 68, 80-83, 1997
九重火山の火山活動について（1997年5月～10月）. 69, 86-90, 1998
阿蘇火山の最近の活動（1997年5月～10月）. 69, 98-100,1998
福田洋一・由佐悠紀・馬渡秀夫（1997）別府地域の地下水変動と重力調査．大分県温泉調査研究会報告，48，31-39.
橋本武志 (1997) 火山噴火に伴う自然電位変動．CA研究会論文集，16-20.
橋本武志 (1998) 地電流ノイズを利用した野島断層周辺の比抵抗調査．月刊地球号外, 21, 82-86.
橋本武志・田中良和・大羽成征・西田泰典・谷元健剛・宇津木充・茂木透・山本圭吾・石原和弘・山崎明・伊藤暢宏・池亀孝光（1998）桜島火山における自然電位測定（序報）．桜島火山の集中観測報告書，印刷中.
Horiuchi, S., Watanabe, M., Kitaoka, K., Tuboi, T., Nakao, Y. and Hongfei, Z. (1997) Some limnological characteristics in arid basin, A case study in Xinjiang area, China. Proceedings of CEReS International Symposium on Hydro-Environment in Asia, 261-266.
神山孝吉・島田　亙・北岡豪一・和泉　薫・江角周一（1997）低バックグラウンド液体シンチレーション法による極域雪氷試料中のHTO濃度測定．南極資料，41, 631-642.
北岡豪一 (1997) 自然の妙，別府温泉．B.CON.PRESS，14, 1，財団法人　別府コンベンションビューロー．
北岡豪一 (1997) 温泉はどうしてわくか．特集「九州温泉国」，FUKUOKA STYLE, 17, 28, 福博綜合印刷.
北岡豪一・大沢信二・大上和敏・由佐悠紀（1997）トリチウムから推定される九重硫黄山における深部水循環．大分県温泉調査研究会報告，48，21-30.
Kitaoka, K., Ohsawa, S., Yusa, Y. and Kusakabe, M. (1997) Changes in chemical and isotopic compositions of deep geothermal waters through subsurface boiling at Kuju-Iwoyama volcano, central Kyushu, Japan. Proceedings of SITH, 216-219.
Kitaoka, K., Horiuchi, S., Watanabe, M., Okuda, S., Mu, G. and Zhou, H. (1997) Water circulation rates in Urumqi and Turfan areas, western China, from the viewpoint of tritium. Proceedings of CEReS International Symposium

on Hydro-Environment in Asia, 35-42.
Mogi, T., Tanaka, Y., Widarto, D. S. and Arsadi, E. M. (1997) Electrical resistivity structure of crust in central Java, Indonesia, and its implication to volcanic activity. IDNDR international symposium, 5.
村上英記・橋本武志・大志万直人・住友則彦・山口覚・本蔵義守 (1998) 注水試験時の電磁気観測. 月刊地球号外, 21, 54-58.
大沢信二・由佐悠紀（1997）温泉の色について（青色温泉水の成因に関する一考察）．大分県温泉調査研究会報告, 48, 41－49.
大羽成征・田中良和・由佐悠紀（1997）伽藍岳の地熱調査（３）．大分県温泉調査研究会報告，48，13-20.
下泉政志・田中良和・歌田久司・濱野洋三（1998）海底同軸ケーブルを用いた地電位差測定．北九州職業能力開発短期大学校紀要、10.
田中麻貴，須藤靖明，筒井智樹（1998）九重火山で観測された地震波形の後続相について．発達史的観点を取り入れた地熱構造の解明とその地熱資源探査への応用に関する研究，28-52.
田中良和・山本哲也（1997）電磁気的手法による火山噴火予知．月刊地球号外，17，180-183.
Tanaka, Y., Oba, S., Utada, H., and Shimoizumi, M. (1997) Electric field observations with the sea bottom communication cable between Nagasaki and Fukue, west part of Japan. Extended abstract of International workshop on scientific use of submarine cables, 46-49.
巽好幸（1997）WG3: 巨大海台掘削計画　ー地球システム変動予測をめざしてー．月刊地球号外，19，208-212.
巽好幸（1997）スーパープルームの起源と活動史を探る．科学，67，480-483.
筒井智樹，須藤靖明，森　健彦，松本良浩，田中麻貴，福田洋一，馬渡秀夫，大上和敏（1998）火山構造探査用データロガーLS8000SHによる臨時観測とその経過について．機動強震アレイ観測のための軽量小型強震計の製作と観測・解析マニュアルの製作，142-152.
筒井智樹，須藤靖明，小野博尉，森　健彦，中坊　真，田中麻貴，吉川　慎，外　輝明，山田年広，増田秀晴，迫　幹雄（1998）地震観測でみた九重火山の活動．発達史的観点を取り入れた地熱構造の解明とその地熱資源探査への応用に関する研究，225-243.
吉川　慎，須藤靖明（1997）阿蘇火山における超伝導重力計の連続観測．超伝導重力計国際ネットワークによる地球深部ダイナミクスの研究，37-40.
由佐悠紀（1997）温泉科学の陸水物理的な側面．日本分析センター広報，31，24-29.
Yusa, Y., Ohsawa, S. and Kitaoka, K. (1997) Changes in the Beppu hydrothermal system (Japan) due to exploitation. Proc. NEDO International Geothermal symposium, 281-288.
由佐悠紀・北岡豪一・福田洋一・大沢信二・馬渡秀夫 (1997) 別府地域の地震(2). 大分県温泉調査研究会報告，48，7-12.

## 学会発表　Conference Presentations

網田和宏・田中良和・大羽成征・馬渡秀夫・橋本武志・下泉政志・笹井洋一，九州東部地域におけるNetwork-MT観測，地球電磁気・地球惑星圏学会（1997年10月2日～5日：北海道大学）．
福田洋一・由佐悠紀・馬渡秀夫，別府地域の重力変化と地下水変動，地球惑星科学関連学会合同大会（1997年３月：名古屋大学）．
福田洋一・由佐悠紀・馬渡秀夫，別府地域における地下水位変動と重力変化の研究（第４報），日本陸水学会（1997年９月：奈良女子大学）．
藤光康宏・茂木透・城森明・田中良和・森川剛夫・城森信豪，空中総合地熱探査システムの研究－赤外画像観測－，日本地熱学会平成９年学術講演会.
橋本武志・田中良和・大羽成征・西田泰典・谷元健剛・茂木透・山本圭吾・石原和弘，桜島火山の自然電位分布（序報），日本火山学会（1997年9月21日～23日：信州大学理学部）．
橋本武志・大志万直人・住友則彦・村上英記・山口覚・本蔵義守，野島断層解剖計画注水試験時の地電位変化，日本地震学会（1997年9月26日：弘前大学）．
橋本武志・槙野豊・山口覚・村上英記・本蔵義守・大志万直人・住友則彦，広域地電流ノイズを利用した野

島断層の比抵抗調査，地球電磁気・地球惑星圏学会（1997年10月2日～5日：北海道大学）．

橋本武志，阿蘇の比抵抗構造調査について，阿蘇火山構造探査シンポジウム（1998年3月5日～6日：東大地震研）．

Horiuchi, S., Watanabe, M., Kitaoka, K., Tuboi, T., Nakao, Y. and Hongfei, Z., Some limnological characteristics in arid basin, A case study in Xinjiang area, China, CEReS International Symposium on Hydro-Environment in Asia (1997年11月5～7日: Chiba University, Japan).

川本竜彦，含水マントルの融解温度とマグマの化学組成，名古屋大学大学院理学研究科地球惑星科学教室教室談話会（1997年12月25日：名古屋大学）．（招待講演）

Mogi, T., Tanaka, Y., Kusunoki, K., Morikawa, T. and Jomori, N., Development of grounded electrical source airborne transient EM, International Conference on Airbone Electromagnetics (1998年2月)．

茂木透・田中良和・城森信豪・森川剛夫・楠建一郎・藤光康宏，地表ソース型空中電磁探査の基礎的研究 (2)，物理探査学会第6回学術講演会（1997年5月）．

茂木透・藤光康宏・江原幸雄・田中良和・楠建一郎・森川剛夫・城森信豪，空中総合地熱探査システムの研究，日本地熱学会平成9年学術講演会．

村上英記・橋本武志・大志万直人・住友則彦・山口覚・本蔵義守，野島注水試験時の電磁気観測，Conductivity Anomaly研究会（1998年2月5日～6日：東大地震研）．

中坊真・京大火山研究センター，阿蘇火山周辺の水準測量結果，日本火山学会（1997年9月：信州大学）．

大沢信二，九重硫黄山1995年の水蒸気爆発に伴う噴気He/Ar比とマグマ性Heフラックスの変化，KS－WHAT研究会（1997年12月13日～14日：附属地球熱学研究施設・阿蘇）．

大沢信二・由佐悠紀，青色温泉水とその発色機構（予察的研究），陸水物理研究会(1997年5月30日～6月1日：大分県別府市ビーコンプラザ）．

大沢信二・由佐悠紀・高松信樹・川村隆夫，青色温泉水とその発色機構に関する予察的研究，日本温泉科学会（1997年8月24日～27日：秋田県鹿角市湯瀬温泉ホテル）．

大上和敏・大沢信二・中川理恵子・高松信樹・由佐悠紀，別府血の池地獄の色彩変化に関わる沈殿物の鉱物組成および温泉水の化学組成の変化，日本温泉科学会（1997年8月24日～27日：秋田県鹿角市湯瀬温泉ホテル）．

Oue, K., Ohsawa, S., Yusa, Y. and Takamatsu, N., Change in color of the bloody hot spring "Chinoike-Jigoku", Beppu geothermal field, Japan, Conference of SITH (1997年12月1～6日: Kanagawa Prefecture Museum of Natural History, Odawara, Kanagawa Prefecture).

小野博尉，阿蘇中岳周辺の地震活動，阿蘇構造探査シンポジウム (1998年3月5日～6日：東大地震研).

小野博尉・菊池茂智・西　潔，九重火山におけるＧＰＳ測量 (3)，地球惑星科学関連学会 (1997年3月25日～28日).

小野博尉・菊池茂智・中坊　真・西　潔，九重火山におけるＧＰＳ測量と地盤変動，日本測地学会第88回講演会 (1997年10月29日～31日:水沢市文化会館).

Kanda, W., Utada, H., Kagiyama, T. and Tanaka, Y., Resistivity Modeling of the Transient EM Data Measured Around Unzen Volcano, SW Japan, 8th Scientific Assembly of IAGA (1997年8月9日:Uppsala).

神田径・笹井洋一・歌田久司・小山茂・小山崇夫・上嶋誠・田中良和・橋本武志・首藤英児，伊東市周辺の比抵抗構造解明に向けて，地球電磁気・地球惑星圏学会（1997年10月2日～5日：北海道大学）．

北岡豪一・大沢信二・大上和利・由佐悠紀，九重硫黄山の熱水活動，陸水物理研究会研究発表会大9回大会（1997年5月30日～6月1日：別府市ビーコンプラザ）．

Kitaoka, K., Horiuchi, S., Watanabe, M. and Okuda, S., Water circulation rates in arid regions of Xinjiang, western China, from the viewpoint of tritium, International Symposium on A New Strategy for Water Environmental Research, 1997 (1997年7月20～25日: Nanjing, China)．

北岡豪一・大沢信二・大上和利・由佐悠紀・日下部実，九重硫黄山における熱水活動，日本陸水学会第62回大会（1997年8月31日～9月3日：奈良女子大学）．

北岡豪一・大沢信二・大上和利・由佐悠紀・日下部実，九重硫黄山における深部水循環―安定同位体とトリチウムからみて―，第62回日本温泉科学会大会（1997年8月24日～27日：鹿角市湯瀬温泉）．

Kitaoka, K., Horiuchi, S., Watanabe, M., Okuda, S., Mu, G. and Zhou, H., Water circulation rates in Urumqi and Turfan areas, western China, from the viewpoint of tritium, CEReS International Symposium on Hydro-Environment in Asia (1997年11年5～7日: Chiba University, Japan).

Kitaoka, K., Ohsawa, S., Yusa, Y. and Kusakabe, M., Changes in chemical and isotopic compositions of deep geothermal waters through subsurface boiling at Kuju-Iwoyama volcano, central Kyushu, Japan, SITH (1997年11月30日～12月7日: Hakone, Kanagawa, Japan).

北岡豪一・堀内清司・渡辺真木・奥田節夫・穆 桂金・周 宏飛，氷河を源流とする半乾燥地域の水循環，"化学/同位体組成からみた深層風化と地下水の貯留性に関する研究"，京都大学防災研究所研究集会9K-5, 3-6, （1998年2月27日：京都大学防災研究所）．

小林正雄・吉岡龍馬・北岡豪一・堀内公子，琵琶湖西岸比叡山東麓一帯の地下水流動系，日本陸水学会第62回大会（1997年8月31日～9月3日：奈良女子大学）．

楠本成寿・福田洋一・竹本修三・由佐悠紀，重力異常からみた九州中部地域東部のテクトニクス，地球惑星科学関連学会合同大会（1997年３月：名古屋大学）．

楠本成寿・山本剛靖・福田洋一・東　敏博・由佐悠紀・竹村恵二・馬渡秀夫・中野健秀・加藤照之，別府湾周辺のGPS観測，地球惑星科学関連学会合同大会（1997年３月：名古屋大学）．

須藤靖明，地震学的に見た阿蘇火山とその構造，阿蘇火山構造探査シンポジウム（1998年3月5日～6日：東大地震研）．

高倉伸一・橋本武志・小川康雄・西垣俊宏，ＭＴ法から推定される阿蘇カルデラの比抵抗構造（序報），Conductivity Anomaly研究会（1998年2月5日～6日：東大地震研）．

高松信樹・中川理恵子・加藤尚之・大沢信二・大上和敏・由佐悠紀，別府血の池地獄沈殿物の微量成分，日本温泉科学会（1997年8月24日～27日：秋田県鹿角市湯瀬温泉ホテル）．

田中麻貴・須藤靖明・筒井智樹 (1997)九重火山で観測された地震波形の後続相について、火山学会1997年秋季大会（1997年9月：長野）．

田中良和・網田和宏・大羽成征・馬渡秀夫・橋本武志・下泉政志・笹井洋一，中部九州におけるネットワークＭＴ観測，Conductivity Anomaly研究会（1998年2月5日～6日：東大地震研究所）．

巽好幸，西太平洋巨大海台掘削計画-CONCORD 国内WG3－，日本地質学会（1997年４月：東京北とぴあ）．

Tatsumi, Y., Whole-mantle-scale magmatism: its role in the evolution of the Earth system. International Symposium for Recent Advance in Material Sciences （1997年10月：姫路工業大学）．

Tatsumi, Y., Kogiso, T., Aizawa, Y. and Shimoda, G., Trace element transport suring dehydration processes in the subducted oceanic lithosphere: experiments and implications for the origin of arc and ocean island magmas. Material Recycling near Convergent Plate Boundaries （1997年11月：フィリピン）．

巽好幸，中新世西南日本弧におけるスラブの融解，　フィリピン海プレート：その構造と地震活動・火山活動・テクトニクスとの関係（1998年１月：東京大学地震研究所）．

筒井智樹，阿蘇火山構造探査に向けて，阿蘇火山構造探査シンポジウム（1998年3月：東大地震研究所）．

雲仙火山人工地震探査グループ（発表者：筒井智樹），雲仙火山における人工地震波のアレイ観測 (2) -雲仙火山周辺の散乱体分布の推定-，地球惑星科学関連学会1997年合同大会（1997年3月　名古屋）．

吉川慎・須藤靖明・森健彦・中坊真・増田秀晴，LS8000WDによる超伝導重力計のデータ収録について，第７回超伝導重力計ワークショップ（1998年1月7～8日：京都大学）．

由佐悠紀・大沢信二・北岡豪一・福田洋一，別府伽藍岳の熱水活動，陸水物理研究会（1997年５月：別府ビーコンプラザ）．

## 共同研究　Collaboration

国内

阿蘇火山広帯域地震観測　　1997年8月24日～30日

参加機関：京大理（須藤，筒井，森，中坊，迫，増田，外，吉川，橋本），東大震研，東大理，地調，防災科研

目的と分担：阿蘇火山で発生する15秒の長周期微動についてその発生様式を明らかにする．観測計画から解析まで全般を分担．

磐梯火山構造探査（人工地震探査）　1997年9月28日～10月4日

参加機関： 京大理（須藤，筒井，森，中坊，吉川，橋本），
北大理，弘前大理，東北大理，東大震研，気象庁，
名大理，九大理，京大防災，富山大理，鹿大理，東工大理
目的と分担：火山噴火予知計画の一環．火山体の速度構造を正確に求める．また，マグマ溜まりなどの異常体を探査する．人工地震観測用地震計の設置を分担．

伊豆半島TDEM観測　1997年3月16日～25日
参加機関： 京大理（田中（良），橋本，馬渡，網田），
東大震研，気象庁，理研，東海大
目的と分担：伊豆半島地域では従来から精力的に地磁気全磁力観測が実施されており，火山活動・地震活動に伴う地磁気変化が観測されている．こうした変化を起こす場としての大地の電気抵抗構造を明らかにする．この地域では直流電車のノイズがひどく，人工制御信号を用いた探査法が不可欠であった．観測点の設営とデータの取得作業を分担．

国際

川本竜彦
含水鉱物の安定領域に関する高温度高圧力実験（ドイツ・バイエルン地球研究所）
1997年7月27日～9月1日，9月21日～11月30日

北岡豪一
中国新疆地域の水文環境（中国科学院新疆地理研究所）
1997年8月

巽好幸
ポリネシアにおける岩石採集（フランス・モンペリエ大学）
1997年9月～10月
インドネシア・バンドン周辺における岩石採集（インドネシア科学院・LIPI）
1998年１月

田中良和
インドネシア・スマトラ島リワ地域における地電位観測網の設置（インドネシア科学院・LIPI）
1997年9月，1998年３月
インドネシア・スマトラ断層周辺のＭＴ観測（インドネシア科学院・LIPI）
1997年9月
インド・ムンバイでの地震予知のための空電観測装置の開発（インド地磁気研究所）
1997年6月

# 教育活動　Education

## 学位・授業　Academics

### 学位

修士

大羽成征　"火山体内部における局所的比抵抗変化の検出可能性の評価"
　指導教官：田中良和

田中麻貴　"九重火山で観測された地震波形の後続相について"
　指導教官：須藤靖明

### 学位審査

須藤靖明
（主査）　田中麻貴（修士　京都大学大学院理学研究科）
（審査員）　Glenda M. Besana（博士　京都大学大学院理学研究科）

巽好幸
（主査）　大栗究（修士　京都大学大学院人間・環境学研究科）
（審査員）　Javad, I（博士　京都大学大学院理学研究科）

田中良和
（主査）　大羽成征（修士　京都大学大学院理学研究科）
（審査員）　坂中伸也（博士　京都大学大学院理学研究科）

由佐悠紀
（審査員）　大羽成征（修士　京都大学大学院理学研究科）
　中林茂（　〃　）
　谷口善文（　〃　）
　古荘次郎（　〃　）

### 講議・ゼミナール

| 科目 | 担当教官 |
|---|---|
| 学部 | |
| 地熱学 | 北岡豪一，須藤靖明，田中良和，由佐悠紀，*竹村恵二*[2]，*福田洋一*[2] |
| 陸水物理学 | 由佐悠紀，*諏訪浩*[1] |
| 火山物理学 | 須藤靖明 |
| 大学院（修士課程） | |
| 水圏地球物理学Ⅱ | 北岡豪一，由佐悠紀，*奥西一夫*[1]，*諏訪浩*[1] |
| 地球熱学・地熱流体学Ⅰ | 北岡豪一，田中良和，由佐悠紀 |
| 地球熱学・地熱流体学Ⅱ | 須藤靖明，*竹村恵二*[2] |
| 応用地球電磁気学 | 田中良和，*大志万直人*[1]，*住友則彦*[1] |
| 環境地球科学Ⅱ | 巽好幸，*井口正人*[1]，*石原和弘*[1] |
| 大学院（修士・博士課程） | |
| 水圏地球物理学ゼミナールⅢ | 北岡豪一，由佐悠紀，*奥西一夫*[1]，*諏訪浩*[1] |
| 地球熱学・地熱流体学ゼミナールⅠ | 大沢信二，北岡豪一，田中良和，由佐悠紀 |

| | |
|---|---|
| 地球熱学・地熱流体学ゼミナールII | 小野博尉，菊池茂智，須藤靖明，筒井智樹，橋本武志，*竹村恵二*[2] |
| 応用地球電磁気学ゼミナール | 田中良和，橋本武志，*大志万直人*[1]，*住友則彦*[1] |
| 環境地球科学ゼミナールII | 巽好幸，*井口正人*[1]，*石原和弘*[1]，*江頭庸夫*[1]，*西潔*[1] |

（[1] 防災研究所，[2] 地球物理学教室）

野外実習

地熱学野外実習 (7月27日～8月1日)
別府：別府温泉噴気の放熱量測定
阿蘇：火山性微動の観測＋地磁気３成分絶対測定

地球電磁気講座3回生実習 (8月4日～8月8日)
杵島岳磁気点にプロトン磁力計4台設置

講議（他大学）ほか

北岡豪一
京都大学防災研究所研究担当

須藤靖明
JICA火山学コース研修生受入 (Gabriel , L. C.)　7月14日～9月12日

巽好幸
集中講義：熊本大学理学部，大阪市立大学理学部，静岡大学理学部，横浜国立大学教育学部

田中良和
特別講義：北海道大学理学部

由佐悠紀
集中講義：九州大学工学部，大分県立芸術文化短期大学

## セミナー　Seminars

地熱学セミナー

| | | |
|---|---|---|
| 1997年 4月18日 | 大上和敏 | 「地熱温泉活動の変遷に関する鉱物学的・陸水物理学的研究（その1）」 |
| | 須藤靖明 | 「阿蘇火山に関する話題」 |
| 5月23日 | 田中麻貴 | 「Distinct S wave reflecter in the midcrust beneath Nikko-Shirane volcano in the northeastern Japan arc」 |
| | 福田洋一 | 「海水準に関する話」 |
| 6月20日 | 大羽成征 | 「二相流の理論」 |
| | 橋本武志 | 「プリュームライズ法による噴気からの熱放出量の推定」 |
| 7月11日 | 中坊　真 | 「地下流体(主に水)の移動に伴う地殻変動」 |
| | 北岡豪一 | 「地下の水は追跡できるか？」 |
| 8月 1日 | 網田和宏 | 「MT法による地殻構造の推定」 |
| | 小野博尉 | 「最近の地殻変動観測から」 |
| 8月22日 | 森　健彦 | 「火山での地震観測からわかる構造」 |
| | 大沢信二 | 「伽藍岳における地熱二相流系の化学的検出と熱収支の見積り」 |
| 10月17日 | 大上和敏 | 「熱水混合モデル計算による，深部熱水の評価」 |
| 11月14日 | 中坊　真 | 「A dynamic balance between magma supply and eruption rate at Kilauea volcano, Hawaii」 |
| | 巽　好幸 | 「沈み込み帯マグマの成因 -コンプリヘンシブなモデルを目指して」 |
| 12月19日 | 網田和宏 | 「Magnetotellurics with a remote magnetic reference」 |

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|---|---|---|
| | 筒井智樹 | 「1998年阿蘇火山構造探査に向けて」 |
| 1998年 1月20日 | 田中麻貴 | 修士論文予行演習 |
| | 大羽成征 | 〃 |
| | 川本竜彦 | 「地球マントル内部での水の循環とマグマの生成」 |
| 3月13日 | 大上和敏 | 博士論文中間発表会 |
| | 森　健彦 | 〃 |

火山研セミナー

| | | |
|---|---|---|
| 1997年 4月25日 | 森　健彦 | 論文紹介 Evidence for gas influence on volcanic seismic signals recorded at Strombori, Maurizio Ripepe, J.V.G.R. Vol. 70, 1996, 221-233. |
| 5月 6日 | 筒井智樹 | 論文紹介 A new map of the Geographic extent of the socorro Mid-Crustal Magma Body, R. S. Balch, H. E. Hartse, A. R. Samford and Kwo-wan Lin, B.S.S.A. Vol.87, 1997, 174-182. |
| 6月13日 | 中坊　真 | 論文紹介 Postseismic deformation following the Landers earthquake, California, 28, June 1992, Zheng-Kang Shen, et. al., B.S.S.A., Vol. 84, no.3, pp. 780-791, 1994. |
| | 橋本武志 | 論文紹介 A two phase hydrothermal cooling model for shallow intrusions, C. R. Carrigan, J.V.G.R., 28, 1986. |
| 8月 8日 | 田中麻貴 | 研究発表 |
| | 須藤靖明 | 〃 |
| 10月 1日 | 小野博尉 | 研究発表 |
| | 森　健彦 | 〃 |

# 研　究　費　Funding

科学研究費補助金

重点領域研究　巽好幸（マントル-核相互作用の地球化学的検証）2,100千円

基盤研究Ａ　巽好幸（中新世西南日本のテクトニクス：マントル内異常高温の総合解析）5,600千円

基盤研究B　由佐悠紀（九州中部地域における地熱構造及び熱水流動過程の研究）2,200千円

基盤研究C　北岡豪一（活火山におけるマグマ性流体と天水の相互作用）2,300千円

奨励研究Ａ　橋本武志（阿蘇火山の浅部熱活動に伴う地下水流動と熱放出過程の研究）1,300千円

受託研究

科学技術振興調整費　巽好幸（スーパープリュームの岩石学的研究）18,715千円

奨学寄付金

社団法人群馬県温泉協会　北岡豪一（地熱流体の研究）335千円

西日本技術開発（株）　須藤靖明　1,000千円

地球科学総合研究所（株）　須藤靖明　1,000千円

共同研究等

東京大学地震研究所一般共同研究　須藤靖明　400千円

京都大学防災研究所一般共同研究　巽好幸　800千円

# 新規導入の装置　Newly Installed Instruments

エネルギー分散型蛍光Ｘ線分析装置

日本電子社製JSX-3220

性能：試料を構成するNaからUまでの質量数の元素の種類を同定することが可能である．また各元素の組成比が得られるために，標準試料との比較により元素の定量も可能である．採取してきた岩石・水試料をそのまま分析装置内でX線照射することにより元素の同定を行うとともに，粉末試料をプレス錠剤化してNa,Al,Si,S,Ca等の元素の定量を行うことができる．

エネルギー分散型電子プローブマイクロアナライザー

日本電子社製JSM-5310型走査電子顕微鏡＋ＬＩＮＫ社製ISIS300-OA型EDS

性能：二次電子線像と反射電子線像の空間分解能は10ナノミクロンで，通常の鉱物・ガラスの化学分析に用する時間は5分間である．EDS検出可能元素はB～Uで，定量分析可能元素濃度は通常0.1重量パーセント以上である．

ピストンシリンダー型高圧発生装置

泉陽社製

性能：0.5 GPa - 3.0 GPa の圧力範囲と1500℃までの温度範囲で実験可能．試料サイズは，直径5 mm 以下，長さ 15 mm 以下（1.5 GPa以下）；直径3.5 mm 以下，長さ 5 mm 以下（3.0 GPa以下）．

蛍光Ｘ線全岩化学分析装置

リガク社製3070＋自動試料交換装置

性能：主成分元素（Si, Ti, Al, Fe, Mg, Mn, Ca, Na, K, P）はガラスビード法（試料0.3g）を用いることによって，また，微量成分元素（Nb, Zr, Y, Sr, Rb, Ni, Pb, Th, Ba）は加圧成形した粉末円盤試料（試料5ｇ）を用いることによって，全岩化学分析を行う．

## 学会活動　Activities in Scientific Societies

北岡豪一
　編集委員：日本陸水学会誌
　評議員：日本地下水学会，日本水文科学会
　運営委員：陸水物理研究会

巽好幸
　編集委員長："The Island Arc"
　評議員：日本地質学会

田中良和
　運営委員：地球電磁気・地球惑星圏学会

由佐悠紀
　編集委員：日本温泉科学会誌
　評議員：日本陸水学会，日本温泉科学会，日本地熱学会
　運営委員長：陸水物理研究会

## 社会活動　Public Relations

大沢信二
　大分県九重町南山田地区温泉地保全検討委員会委員
　地熱開発促進調査辻之岳地域検討委員会委員

北岡豪一
　大分県温泉地保全検討委員会委員（大分県保険環境部）
　道路工事影響検討委員会委員（大分県竹田土木事務所）
　海洋環境評価委員会委員（財団法人 環境科学技術研究所）

須藤靖明
　火山噴火予知連絡会委員
　阿蘇火山ガス安全対策専門委員会委員
　阿蘇地域文化施設連絡協議会委員
　くじゅう山系（硫黄山）防災協議会「２１の会」６月例会講演講師
　九州地方建設局研修会講演講師（1998年3月）

巽好幸
　文部省公開講座講師（1997年11月，新潟万代会館）
　大分県地学研究会年会講師（1997年12月，地球熱学研究施設）
　別府ロータリクラブ月例会講師（1998年１月，亀の井ホテル）

田中良和
　大分県鶴見岳噴火災害検討委員会（２回）
　大分県温泉環境検討委員会（１回）

由佐悠紀
　熊本県小国町議会議員地熱研修会講師（1997年４月，熊本県小国町役場）
　日本温泉気候物理医学会総会特別講演講師（1997年５月，別府ビーコンプラザ）
　大分県文化財保存協議会総会特別講演講師（1997年５月，大分市コンパルホール）
　大分県宅建業協会別府支部研修会講師（1997年７月，別府中央公民館）
　第44回全国中学校理科教育研究会学術講演講師（1997年８月，大分文化会館）

日田中央公民館女性学級講師（1997年８月、日田市中央公民館）
大分熊本県人会例会講師（1998年２月，別府KKR翠山荘）

## 来　訪　者　Visitors

（別府）

| | |
|---|---|
| | 福田洋一（理学研究科助教授）（年間随時） |
| 1997年4月 | Dr. Ian J. Graham (IGNS, New Zealand) |
| | 赤井純治（新潟大学理学部助教授）松岡篤（同助教授）ほか学生20人 |
| | 黄金旺（台湾中原大学教授）ほか４人 |
| | Dr. Mohammed Muniruzzaman (Bangladesh) |
| 5月 | 荒金正憲（別府大学教授）志賀史光（大分大学名誉教授） |
| | 陸水物理研究会一行 |
| 6月 | 湯原浩三（九州大学名誉教授） |
| 8月 | 別府市小中学校新任教師一行20名 |
| | 木内直道（大分県県政広報誌主任） |
| 9月 | 大久保修平（東京大学地震研究所教授）吉田茂生（同助手） |
| | 佐藤雄也（大分県湯布院町長） |
| | 理学部経理掛長ほか |
| 10月 | 中山（大分県庁財務部） |
| | 理学部事務長・司計掛長 |
| 11月 | 高松信樹（東邦大学助教授）ほか学生１人 |
| | 国際地熱研修コース受講生10人 |
| | Dr. Edy M. Arsadi (Indonasia)　ほか１名 |
| | 汪集暘（中国科学院地質研究所教授） |
| 12月 | 国際温泉科学会一行25人 |
| | 竹村恵二（理学研究科助教授） |
| | 鎌田浩毅（総合人間学部教授） |
| 1998年1月 | 大分県立芸術会館立木稠子館長 |
| 2月 | 大分県高等学校理科教員15名 |
| | 福田岩雄（熊本県立天草青年の家）ほか１人 |
| | Stephen Payton（在大阪ニュージーランド総領事） |
| 3月 | 鎌田浩毅（総合人間学部教授） |
| | 藤井敏嗣（東京大学地震研究所長）菊池正幸（同教授）大川勉（同事務長）守屋勝國（同事務官） |
| | 高嶋猛（福井大学講師） |
| | 酒井敏（総合人間学部助教授） |
| | 大分県院内町長ほか１人 |
| | 桑本融（広島女学院大学教授）ほか学生10人 |
| | 理学部施設掛主任・同司計掛主任 |
| | 林宣男（施設部機械設備課技術掛長） |
| | 鈴木晴詞（経理部第３予算掛）ほか |

（阿蘇：火山研究センター）

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| | 吉川美由紀（福岡大学大学院）（年間随時） |
| 1997年4月 | 英・グラナダＴＶ　撮影 |
| | 大分県土木事務所 |
| | 九州地方建設局　立野ダム工事 |
| | 西日本技術開発２名　立野ダム工事関連調査報告書打ち合わせ |
| | 加茂幸介（京都大学名誉教授） |

5月　小林芳正（広島工業大学教授）
野津憲治（東京大学理学部教授）森俊哉（同助手）ほか４人　ガス観測
原口（環境庁九重駐在）
川勝均（東京大学助教授）ほか４人　広帯域地震観測
熊本地方裁判所研修生１２名
熊本学園大米国留学生２名
浜村（理学部用度掛）
岡田弘（北海道大学有珠火山観測所教授）留学生１人
田口幸洋（福岡大学理学部教授）
6月　JICA研修生５人・JICAスタッフ２人
清水洋（九州大学理学部島原地震火山観測所助教授）ほか３人
池辺伸一郎（阿蘇火山博物館）
7月　Gabriel（JICA研修生）
石井紘（東京大学地震研究所教授）
甲南女子高９人
大分県高校理科部会１人　見学下見
清水洋（九州大学理学部島原地震火山観測所助教授）・JICA研修生１人
8月　川勝均（東京大学地震研究所助教授）ほか２人
大分県理科高校教師　１０名
田中貴光（理学研究科大学院生）
自衛隊　２人
小林芳正（広島工業大学教授）川本整（大阪工業大学教授）久保寺章（京都大学名誉教授）
松本良浩（海上保安庁）
東京大学地震研究所・地質調査所８人　広帯域地震観測
太田祐（山口大学教授）引率６人
9月　神奈川県県会議員１３人
NTT広報その他５人　ビデオ取材
中嶋（理学部経理掛）ほか２人　新車購入入札
10月　西日本技術開発・PHOENIX社５人 電磁環境調査
平井（管財課長）木村（事務長）ほか５人
大蔵財務局２人　監査
穴井（九重町総務課長）ほか２人，警察１人 火山ガス警告のため
高橋（環境庁）
田口幸洋（福岡大学理学部教授）　ゼミ
Kutsch（ドイツカソリック大）　火山灰採取
斉藤（地質調査所）ほか５人
松岡（熊本大学）藪崎（京都大学）
11月　田中（写真家）　取材
中川（理学部図書掛）藤井（理学部施設掛）
小川康雄・高倉伸一（地質調査所）Caldwell（ＮＺ）
川勝均（東京大学地震研究所助教授）地質調査所６人
12月　後藤（環境庁）井（阿蘇町）　火山ガス対策のため
松本良浩（海上保安庁）
鹿毛・花宮（気象庁）　測候所統合の件
市原（環境庁）井（阿蘇町）池辺伸一郎（博物館）
江原幸雄（九州大学工学部教授）ほか５人
1998年1月　島津（阿蘇山測候所）ほか２人
福岡・小宮（気象庁）山本（熊本台長）ほか４人
田口幸洋（福岡大学理学部教授）
宮内（林業試験所）
今嶋（経理課長）ほか３人
児玉（長陽村管財課長）
藤崎（県土木事務所）ほか２人　橋梁工事の件

長崎（理学部人事掛）ほか３人
2月　九州地方建設局２人
自衛隊２０人　見学
高倉伸一（地質調査所）
川勝均（東京大学地震研究所助教授）ほか３人
3月　平林順一（東京工業大学教授）野上健治（同助手）
藤井敏嗣（東京大学地震研究所長）菊池（同教授）大川（同事務長）他１人
石戸経士・西祐司・中野（地質調査所）
野津健治（東京大学理学部教授）ほか４人
壺内（理学部司計掛）ほか２人
笠原稔（北海道大学教授）　講義
桑本（広島女学院大）学生６人引率
河野（東京大学理学系研究科）栗田（同助教授）
疋田（鹿児島工高専）ほか２人
鹿毛（気象庁）ほか２人
小宮・高橋（気象庁）ほか３人
三上（気象庁）ほか４人
小林芳正（広島工業大学教授）学生６人引率
永田（共済掛長）ほか２人　金庫検査