Annual Report FY 2001

平成 13 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

Institute for Geothermal Sciences
Graduate School of Science, Kyoto University

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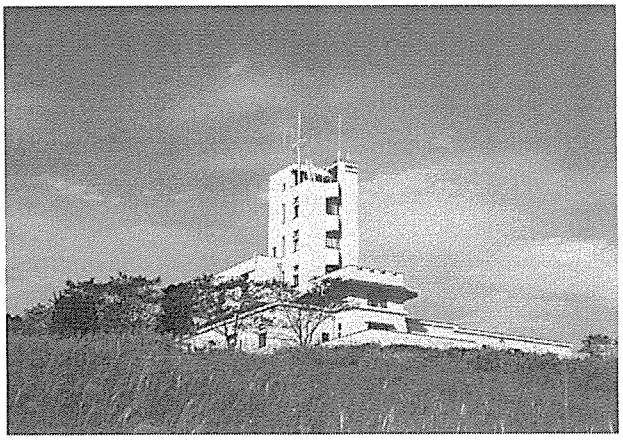

Front Cover Image:
A strombolian explosion in the 1st crater of Mt. Nakadake, Aso volcano in October 1979.(Photo by M. Sako)
表紙の写真
1979 年 10 月の阿蘇中岳第一火口のストロンボリ噴火の様子（迫幹雄撮影）

Editorial compilation by T. Ohkura
Printed in Japan by Touka Shobo

July 2002

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序

平成 13，14 年度の施設長をお引き受けする事になりました．戸惑いながらの 1 年が経過し，支援して下さった方々に心より謝意を表します．

大学の法人化，教職員の非公務員化，そして大学にまで市場原理を導入しようとするなど，研究施設にとって 21 世紀は厳しい門出となりました．研究施設ではここ数年，技官が次々に定年退官されましたが，補任が認められず，特に観測を中心とする研究は重大な危機に直面しています．平成 14 年度までは 4 名の非常勤研究職員が認められ，糊口を凌げますが，平成 15 年からは競争原理に基づくＣＯＥ獲得を余儀なくされます．研究施設は地球科学専攻として，地球物理・地質学鉱物学教室と共に中期目標を立てることになります．この機会に，地球熱学研究施設が京都大学の理学研究科に付属する所以は何かを思索して，将来の展望を見据える事が重要だと感じています．

人事面では，平成 14 年 1 月に地熱テクトニクス研究分野の教授として，竹村恵二氏をお迎え出来ました．第四紀学の立場から，中部九州構造形成の研究が進展する事を期待しています．11 月には古川善紹助教授の勤務地が阿蘇に変わり，外国人客員研究員では，9 月末に Gary M. Thompson 助教授が離任し，10 月から Anthony Hurst 助教授が就任しました．地球物理的観測手法による火山活動研究の進展を期待しています．非常勤研究員では，平成 13 年 5 月 1 日に宮田佳樹氏が着任，6 月 30 日に下田玄氏が退職，7 月 1 日に宮崎　隆氏が着任，9 月 30 日に松影香子氏が退職，11 月 16 日に西村光史，井上（北田）直人両氏が着任，12 月 31 日に宇津木充氏が退職，平成 14 年 1 月 1 日に鈴木由希氏が着任，3 月 31 日に同氏が退職する移動がありました．大学院生では，4 月に新名真裕美氏が入学，14 年 3 月に John Makario 氏が博士号を取得してコロンビアに帰国，平成 13 年 12 月からは中国科学院広州地球化学研究所より Xu Jifeng 氏が日本学術振興会により招聘されました．行政職では，迫幹雄技官が平成 14 年 3 月 31 日定年退官されました．同氏の 43 年間の火山観測と施設の維持管理への尽力に感謝致します．別府では，事務補佐員として 4 月 1 日から土屋寿子氏が着任され，4 月 30 日に米沢由佳氏が海洋科学技術センターに移動されました．

平成 13 年度には，「同位体分析に基づく島弧マグマの起源並びに進化過程の解明」と題する海洋科学技術センターとの共同研究が進展しました．これに関連して，研究員 1 名，技術研究員 2 名，研究補助 1 名，事務・研究補助 2 名の方々が別府に長期派遣されていますが，研究空間の逼迫など受入れ体制に問題が生じており，より良い形での共同研究のあり方を模索したいと思います．

一方，火山研究センターでは，立野ダム建設に関連して，地磁気，地震，地殻変動観測への影響を軽減するための観測設備移転工事が平成 14 年 3 月に完了し，1 年間の並行観測の後，新設備での観測に移行することが可能になりました．関係各位のご努力に謝意を表します．

平成 13 年 11 月 10 日には，別府，阿蘇の双方で一般見学会（オープンハウス）を開催し，地域の方々に研究施設の研究活動の一端を紹介する機会を持つことが出来ました．今後，より充実したものに発展することを願っています．

阿蘇と別府が統合されましたが，100km を隔てた距離は今なお縮めがたく，日常的な対話はもとより，研究上においてさえ，融合は十分ではありません．この活動報告が施設全員の相互理解と研鑽の拠り所として活用されることを願い，また，施設外の方々には，私たちの活動をご理解いただき，ご指導ご助言を賜る機会となれば幸いです．

平成 14 年 5 月

平成 13 年度地球熱学研究施設長

田中良和

Preface

The 21st century started with difficult problems for us, because National Universities will be re-organized as agencies. This means the introduction of competitive principles in research and education. Although many technical officials retired this year, the personnel cutback policy prevents their replacement and caused serious problems for our routine observations and studies. We have four COE fellows in the financial year of 2002, but even for those posts, we will have to compete in the strategic middle-term planning process after next year. In this situation, we should think about why our laboratory belongs to the Faculty of Science of Kyoto University and create a view of the future for our science.

Dr. Keiji Takemura was nominated for professor of geothermal tectonics in January 2002. He will investigate the tectonic development in central Kyushu, with an emphasis on the Quaternary era. Associate professor Yoshitsugu Furukawa changed his work place to Aso in November. Foreign guest Dr. Gary M. Thompson was replaced by Dr. Anthony Hurst, who will work on the Physical evolution of volcanoes.

In the case of the part time instructors, Dr. Yoshiki Miyata arrived on the first of May, Dr. Gen Shimoda resigned on 30 June, Dr. Takashi Miyazaki arrived on 1 July, Dr. Kyoko Matukage resigned on 30 September, Dr. Koshi Nishimura and Dr. Naoto Inoue (Kitada) arrived 16 November, Dr. Mitsuru Utsugi resigned on 31 December, Dr. Yuki Suzuki arrived on 1 January and resigned on 31 March. Of the postgraduate students, Mayumi Shinmyo came to Beppu and John Makario Londono was awarded a PhD and left for Colombia at the end of the financial year. Dr. Xu Jifeng was invited by JASPS in December.

Mr. Mikio Sako, technical officials, retired on 31 March. We appreciate his contribution to maintenance of many observations extending over 43 years. Miss Toshiko Tsuchiya arrived in Beppu for office assistant from 1 April and Miss Yuka Yonezawa changed her post to JAMSTEC on 30 April.

In this financial year, the cooperative study "A study of the origin and evolution process of the magma of island arc based on chemical analysis of isotope" was developed with JAMSTEC. Acceptance of six additional workers at Beppu caused some difficulties over space and contract arrangements. We are hoping to soon resolve these difficulties.

In connection with the construction of the Tateno dam, new observing systems were build for geomagnetism, seismology, and crustal deformation, to avoid the disturbance from the construction. After one year of comparison with existing systems, only the new systems will be operated. Open houses were held at Aso and Beppu on 10 November, aiming to improve communications with the local community. I wish to continue and further develop this activity.

Five years passed after reorganization of BGRL and AVL, however, there has been little progress in systematic joint research projects. We must conquer the distance of more than 100km and make closer connections, especially through cooperative studies. I wish this annual report be put to practical use for improving the mutual understanding among the staff and providing study material for our daily activities. I would like to entreat all people to read it to understand our activities and we look for guidance on further development of the Institute.

Aso, May 2002
Yoshikazu Tanaka, Professor/ Director

構　成　員　Members

教　授　*Professors*

竹村恵二　Keiji Takemura
2002年1月16日着任
田中良和　Yoshikazu Tanaka
(施設長 Director)
由佐悠紀　Yuki Yusa

助教授　*Associate Professors*

古川善紹　Yoshitsugu Furukawa
大倉敬宏　Takahiro Ohkura
大沢信二　Shinji Ohsawa
須藤靖明　Yasuaki Sudo

助　手　*Assistant Professors*

橋本武志　Takeshi Hashimoto
川本竜彦　Tatsuhiko Kawamoto
小野博尉　Hiroyasu Ono
柴田知之　Tomoyuki Shibata
鈴木勝彦　Katsuhiko Suzuki

外国人研究員　*Visiting Faculty*

Anthony Hurst
2001年10月着任
Gary Thompson
2001年9月退職

技　官　*Technical Professionals*

馬渡秀夫　Hideo Mawatari
迫　幹雄　Mikio Sako
吉川　慎　Shin Yoshikawa

教務補佐員　*Research Assistant*

芳川雅子　Masako Yoshikawa

研究支援推進員　*Technical Assistant*

外　輝明　Teruaki Hoka
2001年5月着任、12月退職
増田秀晴　Hideharu Masuda
2001年11月着任

事務補佐員　*Secretaries*

今村町子　Machiko Imamura
土屋寿子　Toshiko Tsuchiya
2001年4月1日着任
米沢由佳　Yuka Yonezawa
2001年4月30日退職

臨時用務員　*Temporal Assistant*

山崎咲代　Sakiyo Yamazaki

非常勤研究員　*Research Associates*

井上（北田）直人　Naoto Inoue(Kitada)
2001年11月16日着任
松影香子　Kyoko Matsukage
2001年9月30日退職
西村光史　Koshi Nishimura
2001年11月16日着任
宮田佳樹　Yoshiki Miyata
2001年5月1日着任
宮崎　隆　Takashi Miyazaki
2001年7月1日着任
下田　玄　Gen Shimoda
2001年6月30日退職
鈴木由希　Yuki Suzuki
2002年1月1日着任、3月31日退職
宇津木充　Mitsuru Utsugi
2001年12月31日退職

大学院生　*Graduate Students*

網田和宏　Kazuhiro Amita　D5
長谷英彰　Hideaki Hase　D4
John M. Londono　D3
中坊　真　Makoto Nakaboh D5
山田　誠　Makoto Yamada D2
吉川美由紀　Miyuki Yoshikawa D3
新名真裕美　Mayumi Shinmyo M1

Measurements of zeta potential in various rock samples of Aso volcano

H.Hase, S.Takakura, T.Ishido*, K.Sato**, T.Hashimoto and Y.Tanaka*

**Institute for Geo-Resources and Environment, Geological Survey of Japan, AIST*

***Institute for Frontier Research on Earth Evolution, JAMSTEC*

Self-potential(SP) electric anomalies are increasingly being observed associated with hydrothermal fields, volcanic activity, and subsurface water flow. It has been widely recognized that anomalies of SP are originated from electrokinetic phenomena such as streaming potential in many cases. Electrokinetic phenomena are induced by the relative motion between fluid and rock(mineral) surface. The rock(mineral) surface in contact with an electrolyte produces electric charge separation at the interface. Such a system is called the electrical double layer. The zeta potential is the electric potential at the slip-plane in the electrical double layer. It is measurable potential in a laboratory experiment, and has been believed as negative in most cases of rock/water systems. SP profile on the ground is strongly influenced by zeta potential of the rocks and soils. Therefore, it is important to measure zeta potentials in areas where SP survey has been conducted.

We measured zeta potentials of 32 rock samples from various places of Aso caldera. Samples were ground and sifted out around the radius of 0.5mm. The XRF measurements were also conducted for each sample in order to know the major component of mineral elements, because the mineral composition influences zeta potential. We obtained positive zeta potential in 14 samples and negative one in other 18 samples without pH-control during measurements. The samples with positive zeta potential correspond to Mt.Takadake and Mt.Kishima areas where we have detected local positive SP anomalies. The samples with negative zeta potential are distributed on hot spring areas and caldera somma.

In case of negative zeta potential, correlation between topographic elevation and SP should be negative. On the contrary Takadake area shows positively correlated topographic effect. That is well corresponded to our experimental result indicating positive zeta potential of Takadake rocks. Zeta potential of rocks has been mostly considered as negative. However, our result suggests that it is sometimes not the case and that we have to be careful with the variation of zeta potential.

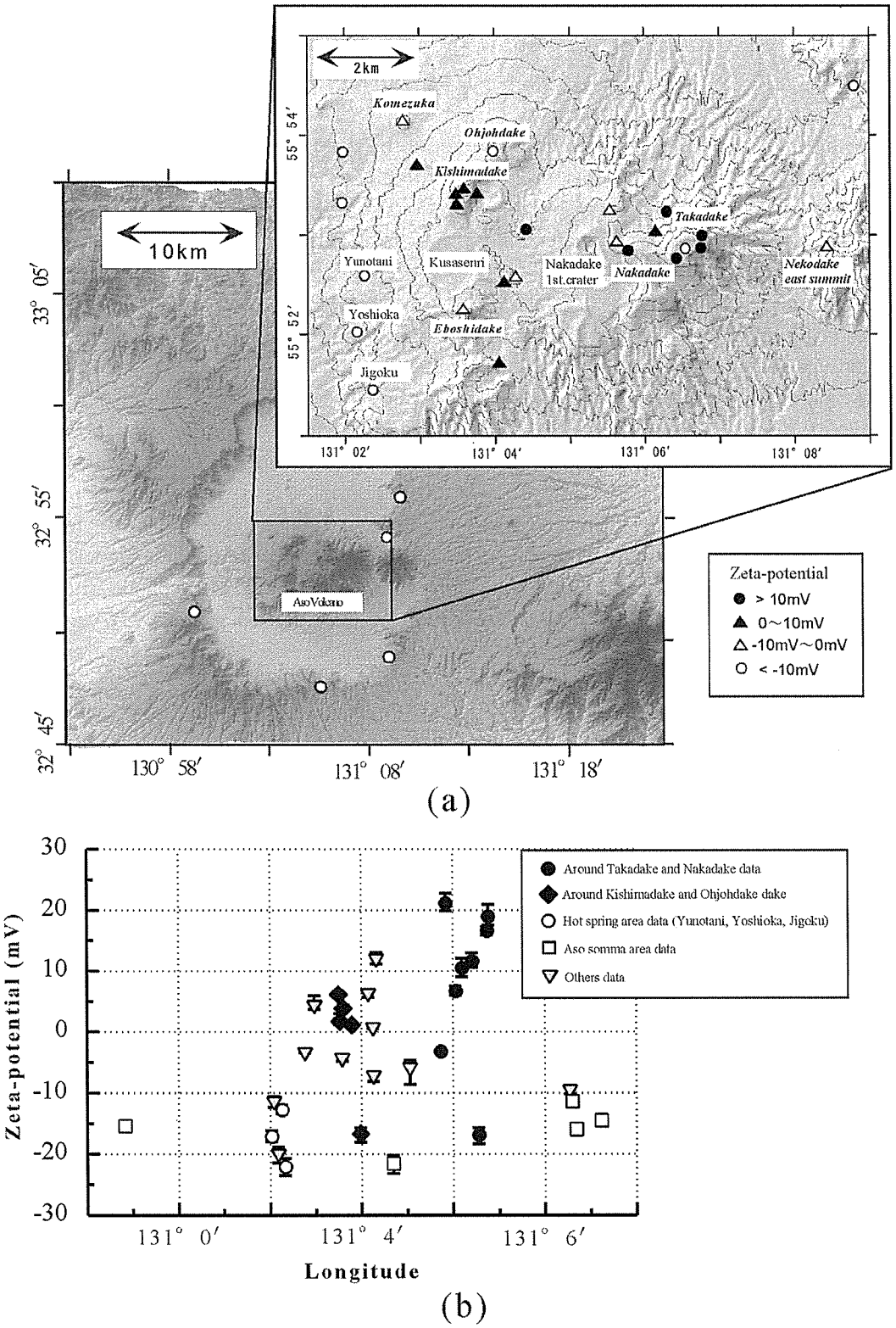


Fig. 1 (a) Collecting points of rock samples with results (without pH-control) of zeta potential (ζ) measurements. Solid circles, solid triangles, open triangles and open circles show $\zeta > 10$mV, 0mV $< \zeta \leqq 10$mV, -10mV $< \zeta \leqq 0$mV and $\zeta <$ -10mV, respectively. (b) Results (without pH-control) of zeta-potential (ζ) measurements with error bar. Solid circles, diamonds, open circles, squares and triangles show results of Takadake and Nakadake area, Kishimadake and Ojodake area, hot spring area (Yunotani, Yoshioka, Jigoku), somma area and other results, respectively.

Heat discharge, water level and geomagnetic changes of the crater lake of Nakadake, Aso Volcano

T. Hashimoto, *S. Ikebe*, *H Ono.* and *Y. Tanaka*

Crater lakes of active volcanoes are considered to be condensers of heat and volatiles from the underlying magmatic systems. Thus, monitoring of physical and chemical parameters such as the temperature, water level and chemical concentrations of a lake is an essential part of surveillance programs at active volcanoes with crater lakes. Nakadake, one of the cones of Aso Volcano has a high temperature crater lake on its flank. We investigated the relationship between water level, surface temperature, and geomagnetic changes of the crater lake during the period 1991-2000. The activity of Nakadake was relatively calm during this period except for some small-scale phreatic activity during the end of 1991 and the middle of 1994.

We estimated the variation of water level and surface area of the crater lake using video images taken by monitoring cameras of the Aso Volcano Museum. Then the variation of heat discharge from the lake surface was calculated in combination with surface temperature which was remotely measured by Japan Meteorological Agency.

In addition, we have operated continuous monitoring of geomagnetic total force in the vicinity of the crater lake for these 12 years. Tanaka (1993) has already reported the geomagnetic changes of an earlier period and proposed a thermal (de/re)magnetisation model with special attention to the activity of 1989-1990. One of the essential conclusions of Tanaka (1993), an equivalent magnetisation source at a depth of 100-200 m beneath the crater related to rapid heat transport by the circulation of shallow ground water, is basically valid also in the following decade. Hence, we regard here the geomagnetic changes as an indicator of the temperature just beneath the crater lake and investigate the relationship between the heat discharge from the crater surface. Following results have been obtained from our analysis.

1. The water level of the crater lake has shown a remarkable change exceeding 70 m during 1991-2000. The consequent surface area change of the lake surface amounts to 150 %, which cannot be ignored in estimation of heat discharge.
2. The main features of the level change can be quantitatively explained by surface evaporation of lake water.
3. The amount of heat discharge from the lake surface (mostly by evaporation process) has been in a range of 50 to 150 MW, whereas the thermal energy concerning the geomagnetic variations has been in a range of 5 to several tens of MW. Thus, roughly one tenth of the total discharge contributes to the heating/cooling of the shallow subsurface region.
4. Long-term variation of geomagnetic intensity has been well correlated with the heat discharge from the crater surface (increasing heat discharge during demagnetisation period). This fact strongly suggests an effective heat transport in vertical direction between the equivalent magnetisation source and the bottom of the crater lake.

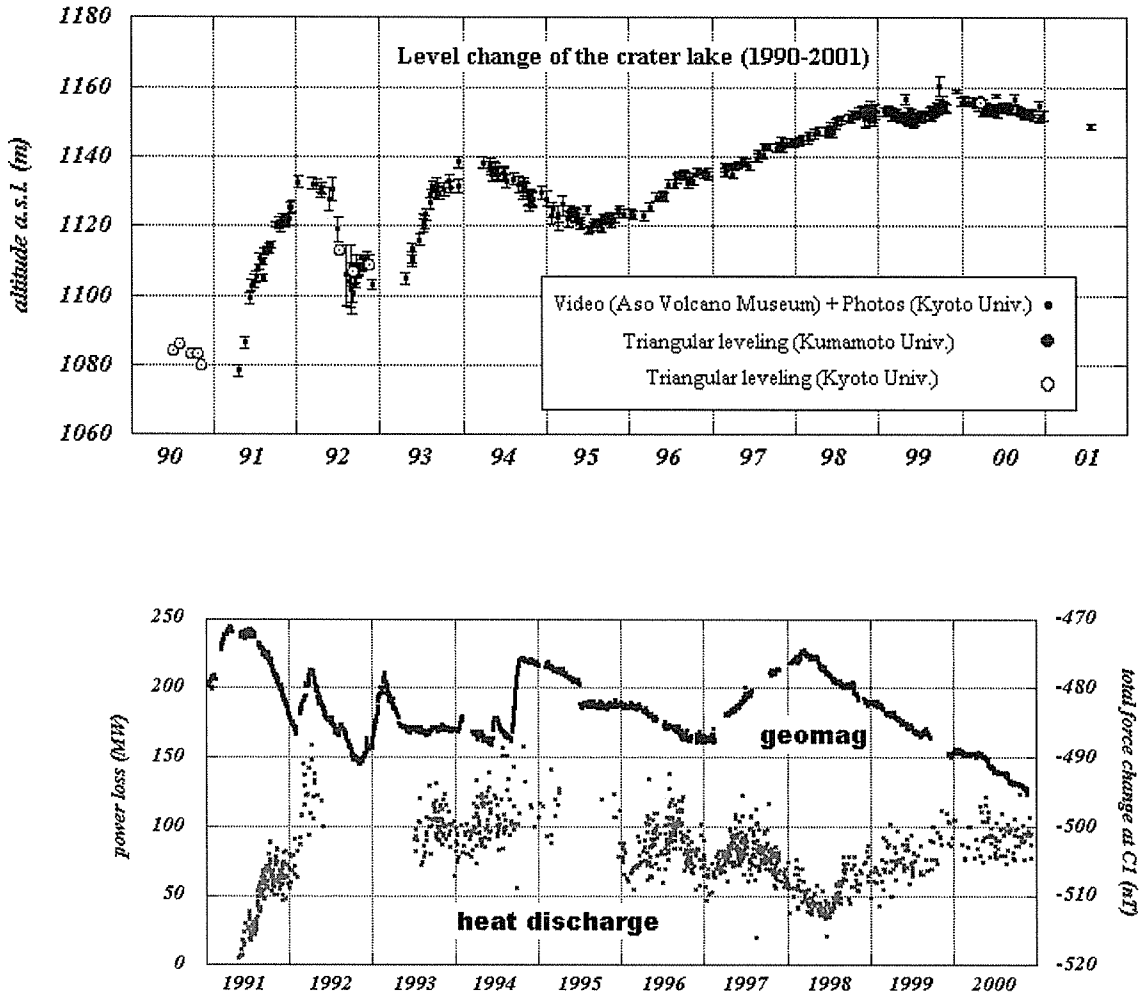


Fig. 1 : (upper panel) Water-level change of Nakadake crater lake during 1990-2001 which is estimated by video images and photographs. Absolute calibration was made by triangular measurements. (lower panel) Variations of geomagnetic total force at C1 station (200 m SW from the crater center) and heat discharge from the crater surface during 1991-2000. Geomagnetic values are after reduction procedure to Aso Volcanological Laboratory.

Direct observation of Mg/Si ratios of H_2O fluids coexisting with mantle minerals

T. Kawamoto, K. Matsukage (Now at Dept. of Environmental Sciences, Ibaraki Univ.), Kenji Mibe (Geophysical Lab., Carnegie Inst. of Washington), Maiko Isshiki (JASRI, SPring-8), Naoki Ishimatsu (Dept. of Physical Science, Hiroshima Univ.), Shigeaki Ono (IFREE, JAMSTEC)

H_2O affects almost all physico-chemical characteristics of the earth forming materials. H_2O can dissolve some degrees of silicate components in high pressure and temperature conditions. Stalder et al., (2001) and Mibe et al. (2002) performed quench experiments in the MgO-SiO_2-H_2O system with Kawaii type multi anvil apparatus. They suggested H_2O fluids coexisting with enstatite ($MgSiO_3$) and forsterite (Mg_2SiO_4) become more Mg/Si ratios as pressure increases in a pressure range from 1 GPa to 10 GPa.

We conducted a series of X-ray diffraction experiments at BL04B2 in SPring 8 in a pressure range from 0.5 GPa to 5 GPa and a temperature range from 800 to 1000 °C, using a Bassett type externally heated diamond anvil cell (Bassett et al., 1993). The following three systems were investigated: de-ionized water with synthesized $MgSiO_3$ crystals, Mg_2SiO_4 crystals, and glass of $MgSiO_3$ compositions. A collimated synchrotron beam with a diameter from 40 to 100 μm was exposed for three minutes and the X-ray diffraction was recorded on the imaging plate at a given temperature. The temperature was monitored using thermocouples that were calibrated using melting temperatures of $NaNO_3$, CsCl, and NaCl. The temperature gradient in the sample was believed to be within several degrees.

We identified crystalline phases coexisting with H_2O fluids and estimate possible Mg/Si ratios of H_2O fluids in the high temperature and pressure conditions. At a pressure range from 0.5 to 3 GPa, Mg_2SiO_4 was observed at the system of $MgSiO_3$ and H_2O. This indicates that chemical compositions of H_2O fluids coexisting with $MgSiO_3$ are enriched in SiO_2 component. At around from 3 to 5 GPa, $MgSiO_3$ and Mg_2SiO_4 are found to dissolve into the H_2O fluid congruently. This suggests that the H_2O fluids have silicate components with 1 - 2 Mg/Si atomic ratios in these conditions. It is likely to conclude that H_2O fluids become more Mg/Si ratios with increasing pressure in the investigated PT conditions, which is consistent with the results based on the quench experiments by the previous workers. The present method using in-situ determination of crystalline phases coexisting with fluid phases can put constraints on the H_2O chemistry in the earth's mantle.

Bassett, W. A., Shen, A. H. Bucknum, M., Chou, I. M. (1993) A new diamond-anvil cell for hydrothermal studies to 2.5 GPa and from -190 °C to 1200 °C. Rev. Sci. Instrum., 64, 2340-2345.

Mibe, K., Fujii, T., Yasuda, A. (2002) Composition of aqueous fluid coexisting with mantle minerals at high pressure and its bearing on the differentiation of the Earth's mantle. Geochim. Cosmochim. Acta., in press.

Stalder, R., Ulmer, P., Thompson, A. B., Günther, D. (2001) High pressure fluids in the system MgO-SiO_2-H_2O under upper mantle conditions. Contrib. Mineral. Petrol. 140, 607-618.

Mid infrared throughput with a 5 μm aperture for H_2O determination of an andesitic glass: Comparison of synchrotron radiation source at SPring-8 with conventional light sources

T. Kawamoto, H. Kagi, T. Handa (Laboratory for Earthquake Chemistry, The University of Tokyo), S. Yamashita (Institute for Study of the Earth's Interior, Okayama University at Misasa), *K. Matsukage* (Department of Environmental Sciences, Ibaraki University), Y. Ikemoto, T. Moriwaki, H. Kimura (JASRI, SPring-8)

There is a rapid decrease in the number of glass inclusions with increasing in size. It is therefore important, to know a minimum size to be analyzed. Mid infrared throughput using a 5 μm aperture was investigated using micro-FTIR spectrometers with conventional lamps at two laboratories and the synchrotron radiation infrared (SR-IR) light source at SPring-8. Transmission spectra of a hydrous andesitic glass plate were measured with a 5 μm aperture. With both the light sources micro-FTIR microscopy can analyze the fundamental O-H vibration in andesitic glass with 1 weight % H_2O through a 5 μm aperture (Figure 1). Spectra obtained at SPring-8 have better S/N ratios due to the brighter and more highly collimated nature of SR-IR compared to conventional lamp sources, although the spectra have undulated background due to a thermal deformation of a mirror located in the storage ring chamber (Figure 2). This undesirable feature is believed to be a result from the thermal deformation character of the first mirror that is located in the storage ring chamber to extract infrared lights from white SR. This mirror will be replaced by a thermally stable one during the summer of 2002. Without this undulated background, the S/N ratios of the spectra with SR-IR at SPring-8 are slightly better than those obtained with conventional light sources using identical accumulation times. The better S/N ratio could be a result of the brighter synchrotron radiation light. This indicates that SR-IR at SPring-8 will be a useful light source for study of phenomena occurring in a relatively shorter time scale such as in-situ analysis of diffusion processes.

The present study indicates that micro FTIR instruments may have the potential to have spatial resolution of 5 μm with an appropriate number of accumulated scans. The availability of the 5 μm aperture, which is much smaller than the usual uses of 15- 40 μm aperture in previous work, has the potential for a significant improvement in the spatial resolution of micro-FTIR analyses.

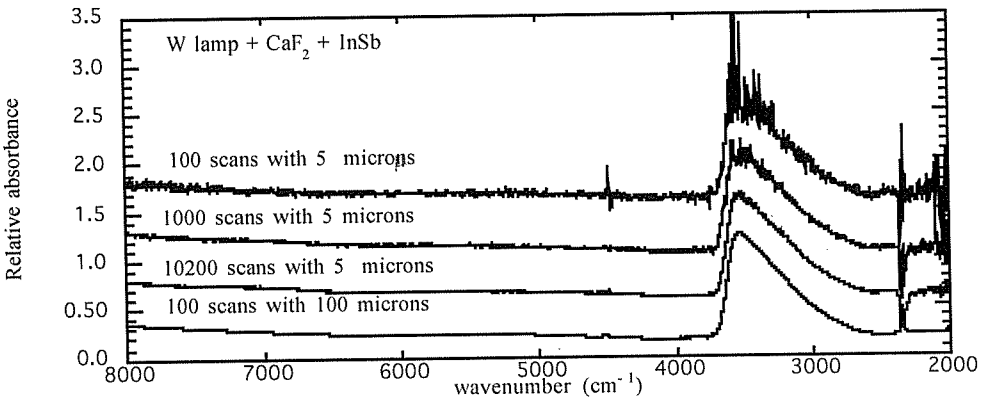


Figure 1 Absorption spectra of the andesite plate obtained by 100 scans with 100 μm rectangular aperture, and by 100, 1000, 10200 scans with 5 μm diameter aperture. All spectra were measured with W lamp, CaF_2 beam splitter, and InSb detector at the Institute of Geothermal Sciences.

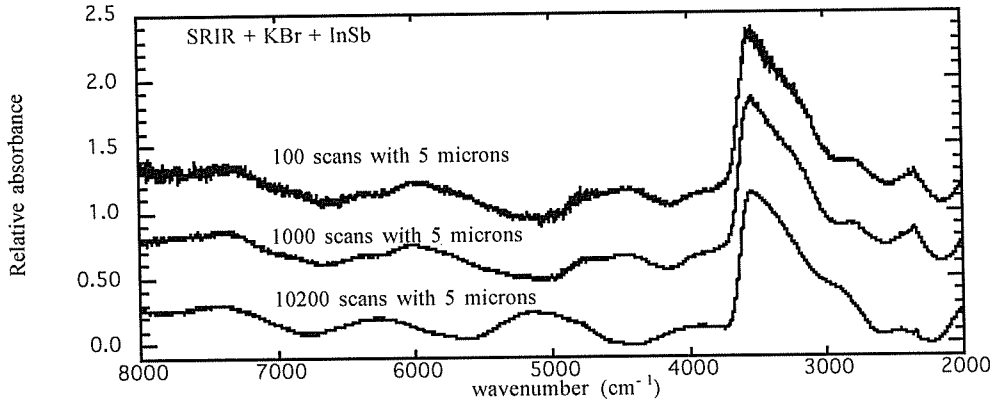


Figure 2 Absorption spectra of the andesite plate obtained by use of synchrotron radiation infrared (SR-IR), KBr beam splitter, InSb detector in the beamline 43IR at SPring-8. All spectra were measured by 100, 1000, 10200 scans with 5 μm diameter aperture.

Three dimensional Geological Structure in Osaka Plain, Southwest Japan
- Integrated Gravity and Geological Interpretation of Basement Structure -

N. Inoue, N. Kitada and K. Takemura

The Osaka Plain is the eastern part of the Osaka Basin, which consists of Pre-Neogene basement rocks and Plio-Pleisticene unconsolidated sedimentary sequence of marine, fluvial, and lacustrine deposits. The geomorphologic and geological studies suggest existence of several N-S trending faults under the Osaka Plain. Many geophysical surveys have been conducted around the faults (Fig.1). The detailed images of underground structure have been obtained from seismic reflection profiles across the faults. The gravity data are particular importance in constructing the three dimensional basement structure. More than 4,000 gravity stations covering the Osaka Plain have been measured by several organizations.

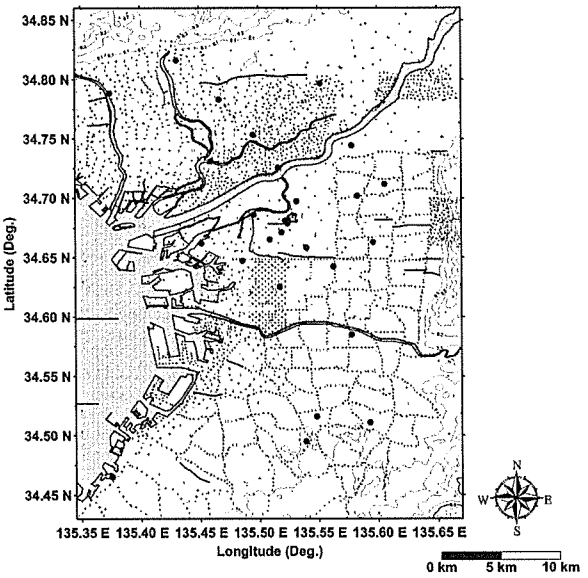


Fig.1. Topographical map of Osaka Basin
Topographical contour is adapted from 250-m DEM (Geographical Institute of Japan). Contour interval is 0.1 km. Solid lines in figure indicate the seismic survey lines. Cross is gravity station. Solid circles are locations of deep borehole and well for hot spring.

For the gravity analysis, the depth of the basement was collected from the results of the seismic reflection survey and drillings for hot springs as the geological constraints. We obtained the liner relationship between the altitude of the basement and the residual gravity anomaly using regression analysis (Fig.2). The residual anomaly was calculated by removing the regional gravity anomaly, which was fitted to polynomial function, from the observed gravity anomaly. The two-layered initial model was estimated from the residual anomaly. We iteratively modified the model to reduce the difference of observed and calculated gravity values using the geological constraints.

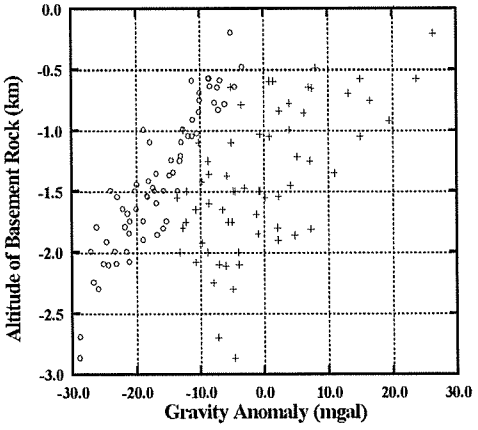


Fig.2. Relationship between gravity anomaly and altitude of the basement rock
Cross and open circle denote the Bouguer anomaly and residual anomaly (Bouguer – regional anomaly), respectively.

Fig. 3 indicates the basement configuration of Osaka Plain with active fault. The N-S steep gradient of the basement in eastern part corresponds to Ikoma fault. The N-S steep gradient in northern central part (Butsunenjiyama - Uemachi fault) does not continue to the southern part. There are over -1.2-km-deep subbasins in the western and eastern part of northern plain. The eastern subbasin tilts to the east. The basement of the southern part is shallower than -1.2 km. The steep gradient is not recognized in the southern part.

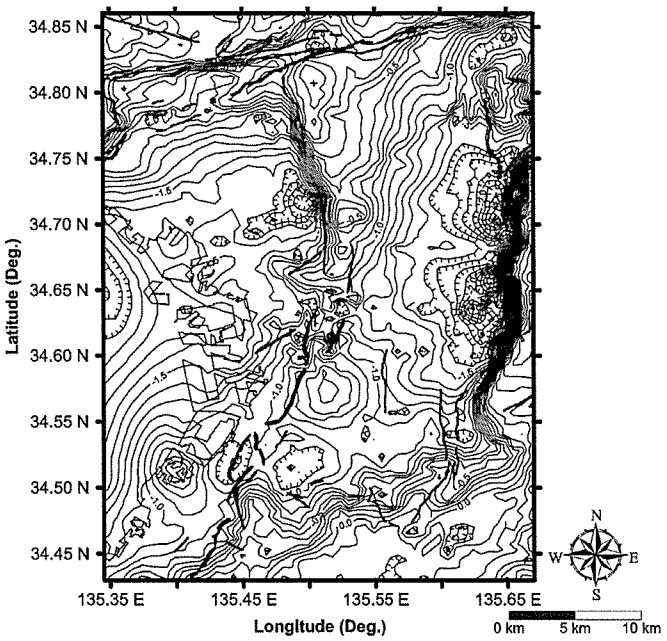


Fig.3. Basement model obtained in this study
Contour interval is 0.1 km. Numerical values are the altitudes of the basement rocks in km. Solid lines are active faults adapted from Geographical Survey Institute.

Integration of High Resolution Seismic and Geological Data of Osaka Bay, Southwest Japan

N. Inoue, N. Kitada and K. Takemura

There are high quality geophysical data in and around the Osaka Bay, Southwest Japan. These data include the regional coverage of high-resolution seismic profiles and gravity stations (Fig.1). Almost of these explorations were conducted after the 1995 Hyogo-ken Nambu Earthquake. The Osaka Bay is the central part of the Osaka Basin which consists of Pre-Neogene basement rocks and Plio-Pleisticene unconsolidated sedimentary sequence of marine, fluvial, and lacustrine deposits. The fifteen well-bedded marine clays are intercalated in the deposits and are referred to Ma −1, Ma 0, Ma 1... Ma 13.

There is the deep borehole over 1500 m in Kobe (GS-K1 in Fig.1). The seismic profiles around Kansai International Airport have been geologically interpreted based on several geological borehole data. We used these geological information as the constraints and interpreted the seismic profiles between Kobe and Kansai International Airport. The seismic reflectors were correlated to fifteen marine clays by compared with a borehole data and interpreted seismic profiles. These reflectors are traced from one profile to another, based on the intersecting points.

Considering the result of interpretation,

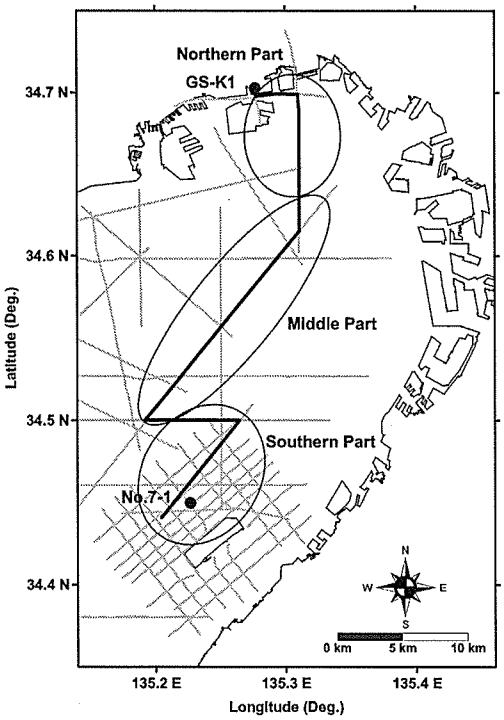


Fig. 1. Index map of seismic profiles and boreholes
Gray lines in figure are seismic survey lines. Thick solid line is the interpreted seismic line in this study. Solid circle shows the location of borehole used as geological constraint.

we divided the interpreted section into the following three areas based on the characteristics of the reflectors: Northern part, Middle part and Southern part (Figs.1 and 2). From the northern to middle parts, the interval of reflectors increases. From the middle to southern parts, the interval of reflectors decreases. In the northern part, sequences of marine clay (from Ma-1 to Ma12) are identified but Ma5 and Ma6 are not recognized around the southern part.

(Submitted to Journal of Asian Earth Science)

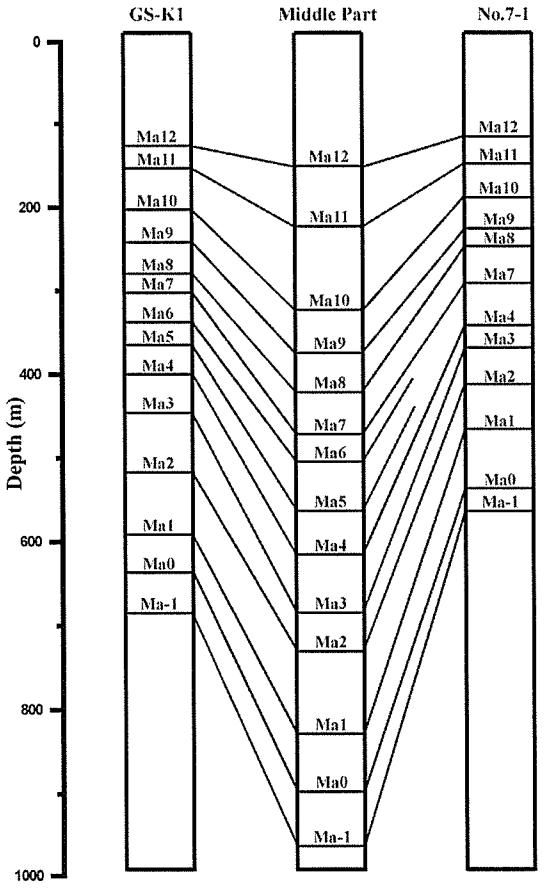


Fig. 2. Relationship of marine clay layers among Northern (GS-K1), middle and Southern (No.7-1) parts in Osaka Basin
The stratigraphy of the Northern and Southern parts were obtained from the borehole stratigraphy of GS-K1 and No.7-1. The locations of borehole GS-K1 and No.7-1 are shown in Fig.1. The stratigraphy of the middle part was obtained from the interpreted seismic sections.

Preliminary results from high temperature Raman spectra of glasses and liquids of $Na_2Si_2O_5$ and $Na_2Si_4O_9$ compositions

K. Matsukage[1] and T. Kawamoto

1: Now at Department of Environmental Sciences, Faculty of Sciences, Ibaraki Univ.

Raman spectra of glasses and liquids of $Na_2Si_2O_5$ and $Na_2Si_4O_9$ compositions were obtained in a temperature range from 300 K to 1673 and 1573 K, respectively at ambient pressure condition (Figure 1). High temperature Raman measurement were performed with Kaiser Raman microscope HoloLab 5000 with 532 nm YAG laser, and Linkam TS 1500 heating stage. The starting materials were quenched glasses with $Na_2Si_2O_5$ and $Na_2Si_4O_9$ compositions. High-frequency part of the spectra is assigned into Si-O^- stretching vibrations of the glasses and liquids and can be decomposed into Q^4 (1140 cm^{-1}), Q^3 (1040 cm^{-1}) and Q^2 (950cm^{-1}) units. In both of $Na_2Si_2O_5$ and $Na_2Si_4O_9$ compositions, the spectra show a shift in the position of Q^4 (1140 cm^{-1}), Q^3 (1040 cm^{-1}) and Q^2 (950cm^{-1}) units to lower frequencies with increasing temperature (Figure 2). In the $Na_2Si_2O_5$ compositions, crystals of $Na_2Si_2O_5$ appeared at 973 K and they congruently melted at 1150 K. These findings are consistent with a phase diagram shown in Figure 192 of Levin et al. (1964). The peak intensities of Q^2 unit of the $Na_2Si_2O_5$ liquids were relatively higher than those of glasses. This change can be a result from possible depolymerization by melting. In the $Na_2Si_4O_9$ compositions, quartz and tridymite were anticipated to crystallize (Levin et al., 1964), but not observed in the present study. Raman spectra in the high temperature and high pressure conditions can be important information to understand the structural state of earth forming materials in the depths of the earth. Combination of Raman microscope and an externally heated diamond anvil cell will be challenged in the future.

Levin, E. M., Robbins, C. R., McMurdie, H. F., 1964, Phase diagrams for ceramists. vol. 1, Am. Cer. Soc., Columbus, U. S., page 601.

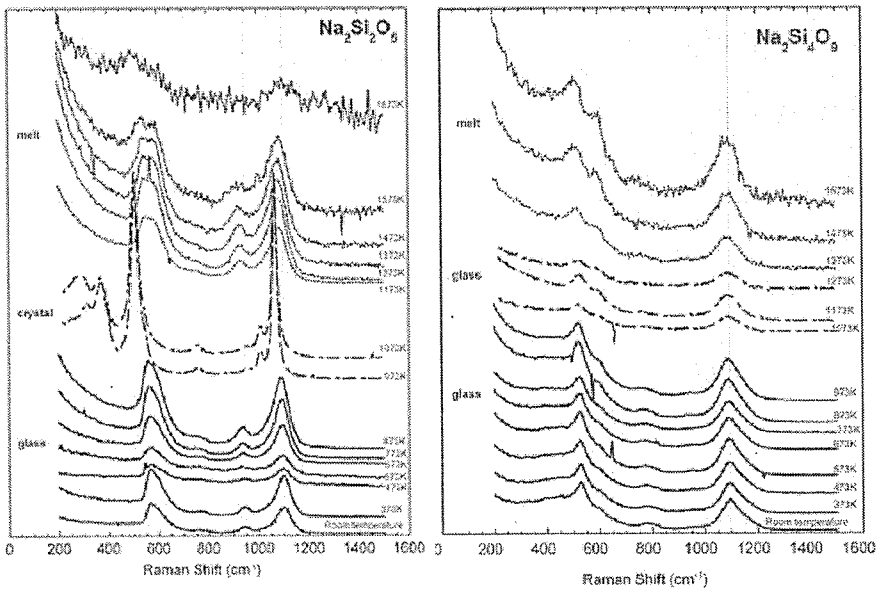


Figure 1 Raman spectra of $Na_2Si_2O_5$ and $Na_2Si_4O_9$ glasses and liquids.

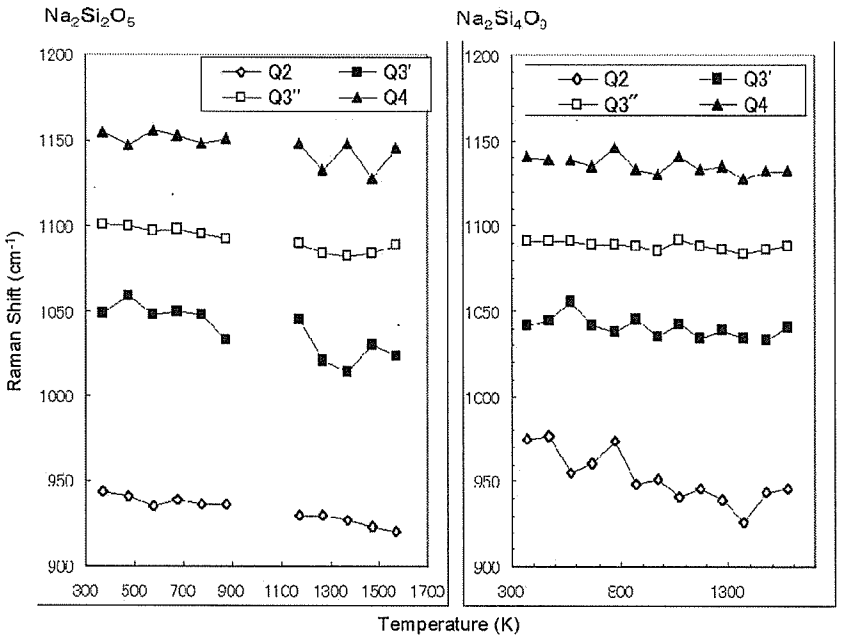


Figure 2 Relationship between temperature and Raman shift.

Material circulation in hydrosphere through the boron isotope ratio

Y. Miyata and T. Shibata

Boron with volatility has two stable isotopes ^{10}B and ^{11}B, which show a large isotope fractionation (about 10%) in nature, because their relative mass difference is very large. Since boron has no redox chemistry in nature, the fractionation between the two isotopes in hydrosphere is possibly controlled by their partitioning between the form of tetrahedral complexes, such as $B(OH)_4^-$ and trigonal complexes, such as $B(OH)_3$, where a partition coefficient strongly depends on pH. The opposite sense of isotope fractionation is specific signature of boron isotope systematics in case of the geochemical phenomena, such as the absorption-desorption processes between solid and liquid, evaporation-condensation processes. Therefore, boron isotope ratio has been expected as an effective tool to understand geochemical processes from a view point different from conventional stable isotopes, such as oxygen and hydrogen.

Although positive thermal ionization mass spectrometry (PTIMS) that has been used for boron isotope measurement exhibit high precision, low sensitivity and complicated sample preparation do not allow us to analyze boron isotope easily. Therefore, we have developed negative thermal ionization mass spectrometry (NTIMS) with high sensitivity and tolerance to a matrix effect, in which is the isotopic composition is measured as $^{10}BO_2^-$ and $^{11}BO_2^-$ ions. It is known that the ionization efficiency of boron greatly depends on filament material and a chemical activator in the NTIMS technique. First of all, we especially examined the following two points to optimize an ion beam of boron using standard reference material NIST951 (boric acid standard) and sea water.

1) The choice of filament materials, platinum or rhenium.

2) The selection of chemical activator, boron free sea water or $La(NO_3)_2$.

As a result of comparison, we select rhenium filament and boron free sea water as an activator to accelerate the generation of BO_2^- ion.

New preparation method of silica-gel activator for lead isotope measurement by hydrolysis of tetraethyl orthosilicate (TEOS)

T. Miyazaki, T. Shibata and M. Yoshikawa

The lead isotope ratio is one of the important forms of geochemical information for earth science. In the same manner as are Sr and Nd isotope ratios, it is powerful and fundamental tool for revealing dynamic processes such as material circulation during the earth's history. Isotope analyses using the thermal ionization mass spectrometer (TIMS) are performed at many laboratories.

However, the analytical process required for lead isotope measurement contains several complicated parts, which are not in the analytical process of Sr and Nd isotope measurements. The distinct difficulty in lead isotope measurement comes from the inability to use an internal standard for the correction of mass fractionation (normalization). This difficulty can be solved to a certain extent by determining a mass fractionation factor by analyzing a lead standard with a well-known isotopic composition (e.g. NIST SRM 981) and applying this same correction factor to all unknowns. However, another distinct difficulty also exists in the preparation of the silica-gel activator, which is usually used in order to enhance the ion beam and to limit instrumental mass fractionation. Silicon tetrachloride has usually been used for the preparation of the silica-gel activator thus far. Besides silicon tetrachloride, silicic acid colloidal solution has also recently been used. However, silicon tetrachloride has intense reactivity, making its handling very difficult. Moreover, it is difficult to make the each silica-gel activator with consistently high efficiency. On the other hand, the silicic acid colloidal solution is often difficult to obtain because of its short supply. Therefore, preparation of a silica-gel activator is problematic even at present. In order to solve these problems in the preparation of a silica-gel activator, we have developed a new preparation method using tetraethyl orthosilicate (TEOS), a technique that mitigates the difficulty resulting from intense reactivity and avoids the problem of the scarcity of the reagent.

TEOS is alkoxide known which has been in existence for many years, and which is synthesized silicon tetrachloride with ethyl alcohol. This reagent is commonly used in various fields such as ceramics, chromatographic absorbents, etc., in order to produce silica particles. Thus, this reagent is easily obtainable. The most widely used methods to obtain silica particles are the so-called sol-gel processes based on the hydrolysis and polycondensation of alkoxysilanes. The hydrolysis of TEOS advances very slowly unlike that of silicon tetrachloride. Therefore, the quality of the silica-gel activator can be easily controlled. We succeeded in producing the optimal silica-gel activator for lead isotope measurement utilizing the TIMS. By using this new silica-gel activator, it is possible to consistently obtain a strong and stable ion beam. For example, when 200ng of lead samples (NIST SRM 981) are measured, a beam intensity (^{208}Pb) of 4000mV or more can be obtained in almost all measurements. In addition, the beam intensity decayed less than 40% over the course of about 30 minutes.

The improvement in the reproducibility of the isotope ratio is very important for improving the reliability of analysis. Repetition measurement of lead reference material (NIST SRM 981) using the new silica-gel activator indicates an improvement in reproducibility. The measurement using new silica-gel activator was able to decrease the error about 66% in comparison with the measurement using old silica-gel activator made from silicon tetrachloride. Although there is still room for improvement, we can presently measure 25ng or more of lead samples with about same reproducibility (Fig.1). By adopting the new preparation method for the silica-gel activator, we can more simply and accurately measure lead isotope ratios.

(Submitted to Chemical Geology)

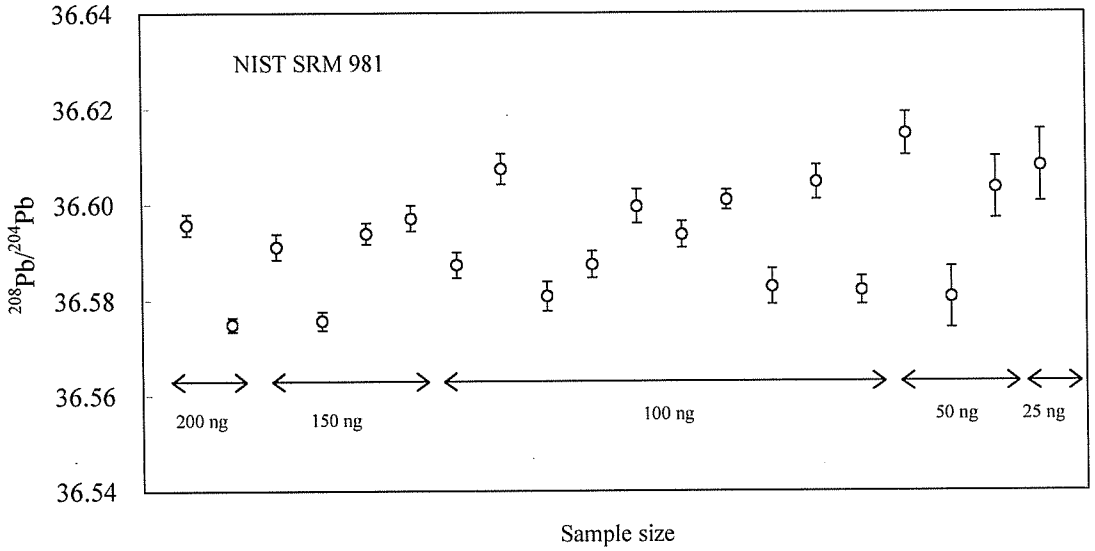


Fig. 1. Variation of $^{208}Pb/^{204}Pb$ ratios for sample sizes from 25 to 200 ng. The vertical bar with open circle shows error in a 2 σ_m of each measurement.

Optimal "Re-filament" for high reproducibility of the isotope ratio in a lead isotope measurement by thermal ionization mass spectrometer (TIMS)

T. Miyazaki, T. Shibata and M. Yoshikawa

Improvement in the reproducibility of an isotope ratio is very important for improving the reliability of an isotope analysis. For the purpose to realize high reproducibility of the isotope ratio in a lead isotope measurement, we developed optimal measurement conditions (e.g. procedure for sample loading, filament temperature and heating process, material of filament). In the experiment to develop the optimal measurement conditions, it became clear that the influence to give to the reproducibility of the isotope ratios was different in each Re-filament purchased from different companies, in spite of same "Re-filament (Re-ribbon)".

In this report, we examine the reproducibility of the isotope ratios measured using the Re-filaments purchased from the different companies by repetition measurements of a lead reference material (NIST SRM 981).

All measurements were carried out on a multicollector mass spectrometer (Finnigan MAT 262® with 9 Faraday cup collectors) at the Institute for Geothermal Sciences, Kyoto University. We repeatedly analyzed solution of 100 ppm of NIST SRM 981 (99.9999% common Pb) using a silica-gel activator prepared by our new method described in Miyazaki et al. (in this issue). In order to restrain isotope fractionation during measurement, a filament temperature of around 1200°C was used. The acquisition of data started at 15 minutes after preheating and beam adjustment. The data were obtained in the so-called "static mode," in which the ion beam of each mass number was collected by a fixed Faraday cup. These data were computed from 100 repeated measurements,

comprising ten scans in each of ten blocks. The data acquisition time took about 30 minutes for each measurement.

We adopted the following procedure for loading on the filament. The solution of NIST SRM 981 was mixed with 12.5μl of 0.075N-H_3PO_4 in a Teflon vessel, which was then put on a hot plate (100°C for 30 minutes) to reduce the liquid volume of the mixture. This mixture was then mixed with 0.6μl of silica-gel just prior to the sample loading on a Re single filament (Thermo Finnigan©, Nilaco© or H. CROSS© ; 0.75 mm wide). The loads were concentrated on the filament (2 mm width). Afterward, the filament current was gradually increased, until the fumes of phosphoric acid were observed. We loaded 100-200 ng of lead for measurements.

Measured lead isotopic ratios over 16 to 20 separate experiments of NIST SRM 981 (100-200 ng) using the each Re-filament purchased from the different companies are listed with average values and uncertainties in Table 1. The measurements using the Thermo Finnigan© Re-filament reduced error by about 32% or 48% ($^{208}Pb/^{204}Pb$) in comparison with the measurements using the Nilaco© or H. CROSS© Re-filament (Table 1 and Fig. 1), respectively.

From the above result, it is concluded that the Thermo Finnigan© Re-filament is more optimal than two other products to get high reproducibility of the lead isotope ratios.

Table 1. Measurement results of NIST SRM 981

	Uncorrected ratios			
	n	$^{208}Pb/^{204}Pb$	$^{207}Pb/^{204}Pb$	$^{206}Pb/^{204}Pb$
Thermo Finnigan©	16	36.5909 ± 0.0099	15.4566 ± 0.0032	16.9106 ± 0.0025
Nilaco©	18	36.5682 ± 0.0145	15.4493 ± 0.0046	16.9054 ± 0.0035
H. CROSS©	20	36.5868 ± 0.0191	15.4556 ± 0.0059	16.9099 ± 0.0044

*Error is 1 σ SD.

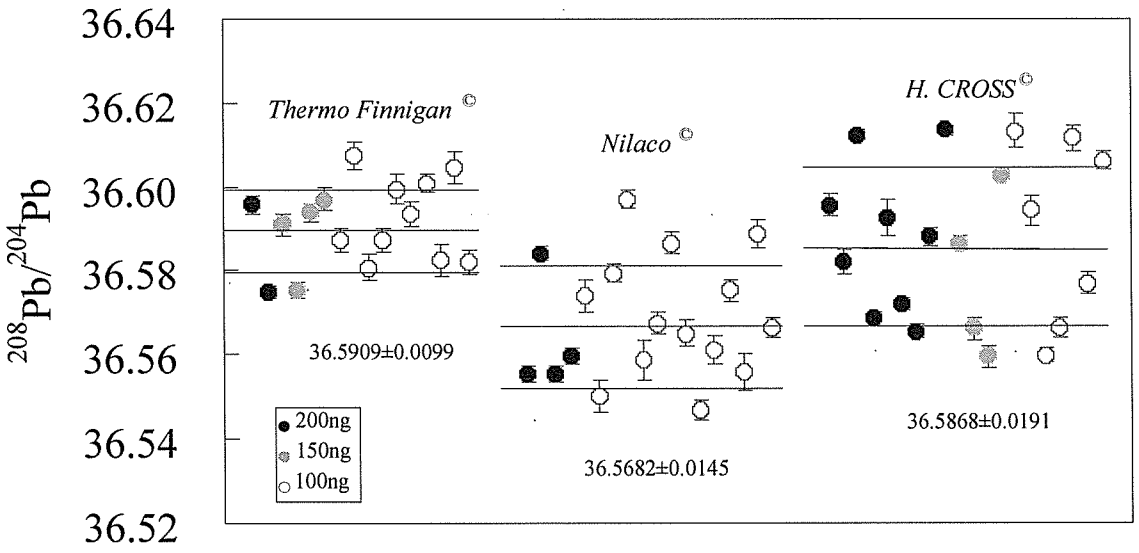


Fig. 1. Variation in $^{208}Pb/^{204}Pb$ ratios for sample sizes ranging from 100 to 200 ng. The vertical bar with open circles shows the error in $2\sigma_m$ of each measurement. The horizontal solid and dotted lines show the average and range of error (1σ) in the $^{208}Pb/^{204}Pb$ ratios for sample sizes ranging from 100 to 200 ng.

The cause of ^{13}C and ^{18}O enrichment in the Eppawala carbonatite body, Sri Lanka :Limestone assimilation by carbonatitic magma

T. Miyazaki, T. Morikiyo, M.W.K. Weerakoon, H. Kagami and K. Dahanayake

Sr, Nd, C, O and S isotopic composition and an abundance of REE are reported for Sri Lanka's Eppawala carbonatite, the origin of which is still a matter of debate. The Eppawala carbonatite body is located about 20km south of Anuradhapura, Sri Lanka. Distributed in this area are metamorphic rocks of the amphibolite to granulite grade, such as hornblende gneiss, granitic gneiss and charnockite. Sm-Nd isochron ages of garnet-silimanite-biotite gneiss and migmatitic gneiss are 607± 23Ma and 626±16Ma, respectively (Weerakoon et al., 2001). Together, these rocks are classified as the Wanni Complex. The Eppawala body is composed solely of spinel-apatite-calcite carbonatite; peralkaline silicate rocks are not observed. The striking features of the Eppawala body include the occurrence of green spinel, plastic deformation structures, and a lack of fenitization. The biotite-apatite-whole rock Rb-Sr isochron age for the carbonatite from a single locality is 493±5Ma (Weerakoon et al., 2001).

The $\delta\ ^{13}C_{PDB}$ and $\delta\ ^{18}O_{SMOW}$ values of the Eppawala carbonatites range from -2.8 to -1.1 (‰) and from 12.8 to 16.7 (‰), respectively. On the $\delta\ ^{13}C_{PDB}$ vs. $\delta\ ^{18}O_{SMOW}$ diagram, the values of the Eppawala carbonatites fall exactly in the middle between the field of mantle CO_2 and marine limestone. The initial Sr isotope ratios of the carbonatite range from 0.7048 to 0.7055 [from 13.7 to 23.4 ε Sr (T)], and the initial Nd isotope ratios range from 0.51159 to 0.51169 [from – 6.6 to – 4.6 ε Nd (T)]. These data are plotted in the lower-right quadrant in the epsilon Sr vs. epsilon Nd diagram. The Eppawala carbonatites have a wide range of initial Sr isotope ratios and Sr concentrations. A positive correlation is observed between the initial Sr isotope ratios and 10000/Sr values. REE concentrations in the Eppawala carbonatites are very high and are within the range of typical carbonatite.

The C, O and Sr isotopic features of the Eppawala carbonatites are best explained by the results of assimilation. The mixing calculation indicates that primary carbonatite magma was assimilated with an equal amount of marine limestone plus crustal silicate rock. The following facts are consistent with this interpretation. The carbonatites contain abundant fragments of silicate rock and magmatic olivines. These olivines are surrounded by coronal structures generated by reaction (8olivine + 13calcite + $1H_2O$ + $9CO_2$ = 1tremolite + 11dolomite). The minerals consistent with the coronal structure are tremolite and dolomite, with the latter surrounding the former. This coronal structure indicates the infiltration of water into carbonatitic magma.

Because of the very high concentrations of Sr and Nd in carbonatite magmas, their low melting temperatures and their probable rapid transport through the crust, crustal contamination of these elements is minimal in comparison to most other mantle-derived magma types. Therefore, in spite of the assimilation with crustal materials, the initial Sr and Nd isotope ratios of the Eppawala

carbonatites are likely to be representative of their mantle source. The Eppawala carbonatites have high initial $^{87}Sr/^{86}Sr$ ratios and low initial $^{143}Nd/^{144}Nd$ ratios relative to bulk earth and CHUR. Thus, these isotope ratios imply a mantle enriched with alkali metal and LREE as the source, which corresponds with the EM1-type mantle.

Reference

Weerakoon, M.W.K., Miyazaki, T., Shuto, K. and Kagami, H. (2001) Rb-Sr and Sm-Nd geochronology of the Eppawala metamorphic rocks and carbonatite, Wanni complex, Sri Lanka. Gondwana Res., 4, 409-420.

EDM and Rapid Static GPS Measurements at Kuju Volcano, Kyushu, Japan

M. Nakaboh, H. Ono, M. Sako, Y. Sudo, T. Hashimoto and A. W. Hurst

A phreatic eruption occurred at Kuju volcano in October 1995. We deployed an EDM network around the active craters of the volcano just after the eruption. Slope distances of the survey lines in the northern network have tended to contract, whereas those in the southern one tended to extend. The maximum contraction observed in the northern network was 70 cm over 6 years. A spherical volume decrease just beneath the fumarolic area is a plausible model for these changes in slope distances. A noteworthy feature is that over 6 years after the phreatic eruption ended, the deflation rate is still approximately linear.

We deployed a GPS network around the same area in Feb 1999, and added 25 GPS points for rapid static measurements to the network in Apr. 2001, aiming to obtain denser deformation data and to construct more sophisticated model considering the topographic effects or the shape of the deflation source. We carried out GPS measurements in Feb. 1999, Apr. 2001 and Jul. 2001. Fig. 2 shows the horizontal displacements detected by GPS rapid static method between Apr 2001 and Jul 2001.

We also estimated the thermal energy discharge by fumaroles from the new craters. Temporal variation of the energy discharge is well correlated with the observed deflation rate (Fig. 2). It is strongly suggested that the ground deformation around Iwoyama is caused by the deflation volume of a geothermal reservoir.

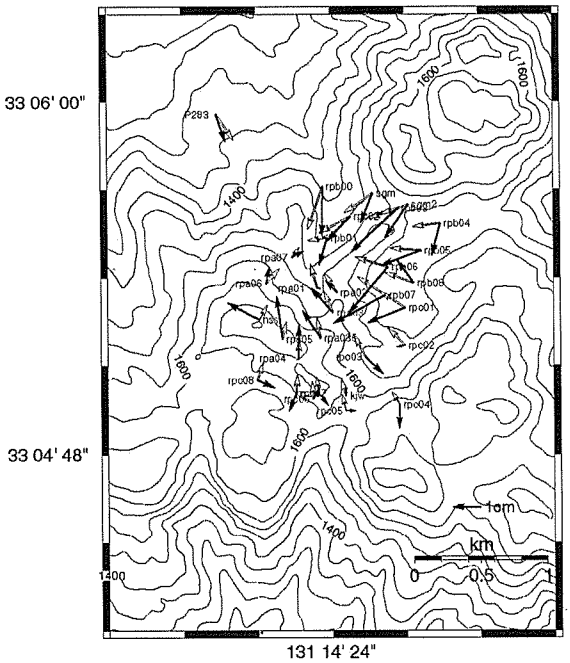


Fig. 1 Horizontal displacements are depicted as solid arrows detected by GPS from Apr 2001 to Jul 2001. Theoretical displacements of Mogi model are shown as open arrows.

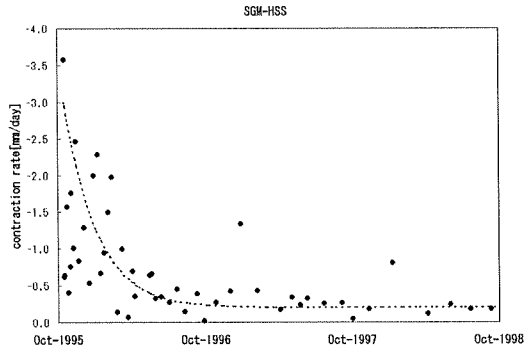


Fig. 2 (a) Contraction rate of the slope distance (SGM-HSS) for the first three years.

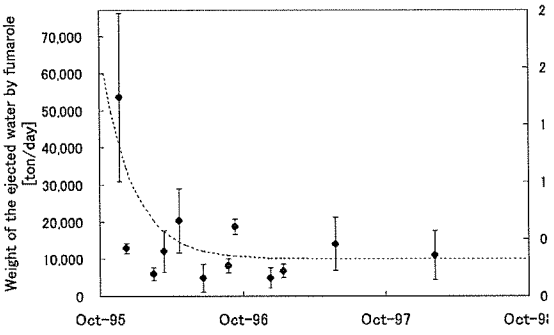


Fig.2 (b) Temporal variation of fumarolic energy flux and equivalent weight from new craters during the same period as (a).

Infrared spectroscopy of melt inclusions trapped within phenocrysts of quartz and plagioclase in Unzen dacite

K. Nishimura, T. Sugimoto (Kyushu University Museum), S. Yamashita (Institute for Study of the Earth's Interior, Okayama University at Misasa), T. Kawamoto

Glass inclusions in phenocrysts can provide information about compositional variation present in preeruptive magma. In the last decades, infrared (IR) spectroscopy has become a powerful analytical tool to study water in glass inclusions (Yamashita et al., 1997). The fundamental OH vibration band at 3570 cm^{-1} is widely used for total water determination. The absorption peak height of this band obeys the Lanbert-Beer's law and hence is useful to determine water concentrations in glass inclusions. However, the molar absorption coefficient of this band displays a strong composition-dependence (e.g., Yamashita et al., 1997). We determined molar absorption coefficient of total H_2O in glass of rhyolitic composition and applied the results to natural melt inclusions (rhyolitic glasses) trapped within phenocrysts of quartz and plagioclase in Unzen dacite.

Yamashita (1999) synthesized a series of hydrous glasses of rhyolitic compositions (77.4 wt.% SiO_2 under anhydrous condition) and determined those water contents by using H_2 manometry. These glasses were doubly polished and analyzed by FTIR spectrometer to determine molar absorption coefficient. Figure 1 shows the result of calibration for the synthesized glasses. The molar absorption coefficient of 3570 cm^{-1} band is determined as 9.3 ± 0.2 (m^3/mol m). With IR spectroscopy using this coefficient, water concentrations up to ~4wt.% in rhyolitic glasses can be determined accurately.

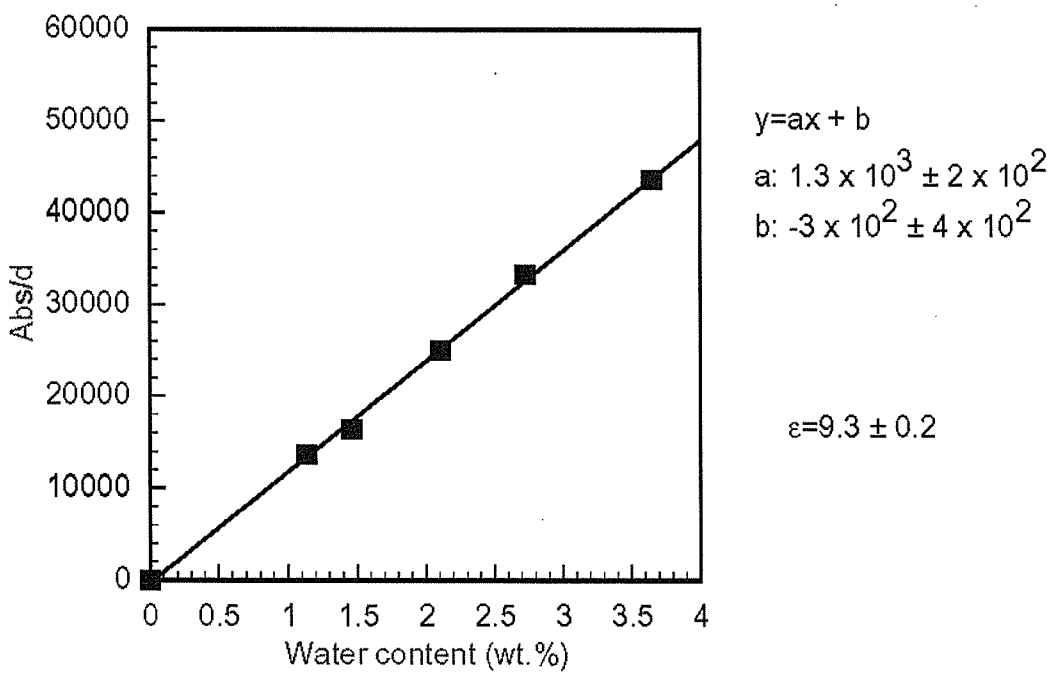


Figure 1 Relationships between normalized absorbance and water content in synthesized rhyolitic glasses. *Abs* and *d* mean absorption peak height and sample thickness, respectively. A molar absorption coefficients (ε = 9.3 ± 0.2 m^3/mol m) is determined for present data set.

The major element and water concentrations are currently analysed in glass inclusions from plagioclase and quartz phenocrysts in Unzen dacite. The major element concentrations of the glass inclusions are rhyolitic (SiO_2 content is > 75 wt.%). These inclusions have a small bubble and are sometimes partially crystallized. In order to determine water concentrations, these inclusions are homogenized by melting and quenching on a heating stage under microscope. Thereafter, the inclusions are doubly polished and analyzed by FTIR spectrometer.

Yamashita, S., Kitamura, T., Kusakabe, M. (1997) Infrared spectroscopy of hydrous glasses of arc magma compositions. Geochem. J. 31, 169-174.

Yamashita, S. (1999) Experimental stydy of the effect of temperature on water solubility in natural rhyolite melt to 100 MPa. J. Petrol. 40, 1497-1507.

Crystal settling and migration of solid wall in silicic magma chambers consisting of a eutectic melt and preexisting crystals

K. Nishimura

Effects of the settling of preexisting crystals on the compositional structure in silicic magma chambers are investigated numerically. The model assumes a two-dimensional magma chamber consisting of 20 vol.% preexisting crystals and a eutectic melt with melt viscosities of 10^8, 10^6 and 10^4 Pa s. The distribution of preexisting crystals is regarded as a compositional structure. The compositional structure is controlled by balance of the rate of crystal settling and the migration rate of the solid wall (capture front). In the case of a magma chamber with melt viscosity of 10^8 Pa s, an almost homogeneous distribution of preexisting crystals is maintained throughout the cooling history because the migration rate of the capture front is much faster than the rate of crystal settling. In the case of a melt viscosity of 10^6 Pa s, crystal capture and settling processes form concentrically zoned structure which can be characterized by (1) normally zoned structure at the shallow level and (2) reversely zoned structure at the deeper level. In the case of a melt viscosity of 10^4 Pa s, vertically zoned structure is formed on a short time scale. In general, vertically zoned structure is found in rhyolitic magma chambers and, while concentrically zoned structure is found in granitic magma chambers. This contrast comes from viscosity difference between granitic melts and rhyolitic melts.

Structure of the upper part of the Philippine Sea plate estimated by later phases of upper mantle earthquakes in and around Shikoku, Japan

T. Ohkura

In the Chugoku, Kinki and Shikoku districts, southwest Japan, a distinct pair of later P and S phases is frequently observed after P and S phases for earthquakes shallower than 60 km occurring in the vicinity of the west Seto Inland Sea which were caused by the subduction of the Philippine Sea (PHS) plate. The observed phases are dominant in all three-components with an apparent velocity almost equal to the P and S velocity of the lower crust. If the upper mantle earthquakes take place within a low velocity oceanic crust overlying the high-velocity PHS plate, and if this oceanic crust is in contact with the continental lower crust between the sources and the receivers, waves which travel through the oceanic and the lower crust can be observed as later phases. Travel times and synthetic waveforms were calculated using a three-dimensional ray tracing method and a three-dimensional Gaussian-beam method. The calculated travel times and amplitudes of the later phases are in good accordance with the observed values. This suggests that in the subducting oceanic crust a gabbroic phase remains without transformation to eclogitic rocks to depths of about 60 km. Similar later phases are observed in the Chugoku district from the upper mantle earthquakes beneath the Shikoku district. This suggests the continental lower crust is in contact with the subducting oceanic crust beneath Shikoku and that no mantle wedge exists.

Geodynamics in the Philippines-eastern Indonesia: Crustal deformation and plate subduction

K.Ooba,T. Tabei, F. Kimata and ***T. Ohkura***

We investigate tectonic deformation in the Philippines-Eastern Indonesia revealed by GPS campaign measurements since 1997. The studied area covers deformation zone extending from Mindanao to NE Sulawesi across the Molucca Sea, where westward motion of the Philippine Sea plate at a rate over 10cm/yr with respect to the Sundaland is consumed by multiple subduction at the Philippine, the Halmahera and the Sangihe Trenches.

We collected GPS data at Sangihe Is. and Talaud Is. on the Molucca Sea, in addition to the measurements at Luzon, Palawan, Mindanao and NE Sulawesi. Campaign data were processed together with the data obtained at IGS and other continuous stations distributed in the western Pacific region. Several stations were common to the GEODYSSEA campaigns.

Comparing horizontal velocities at common sites with the GEODYSSEA results, we find a small systematic bias of about 1cm/yr. Since the bias is chiefly attributed to the difference of the global reference frame used for the analyses (ITRF96 and 97), we consider that two sets of velocity field are consistent when discussing regional tectonic deformation. We find a convergence of 22mm/yr between Sangihe and Talaud, which are separated by only 130km from east to west. Velocity at Sangihe is as small as 15mm/yr westward relative to the Sundaland, showing no significant difference with the velocities at Palawan, Zamboanga (W Mindanao) and Manado (NE Sulawesi). In contrast, motion at Talaud seems to have a correlation with the motions at Davao (C Mindanao) and Manila (Luzon). Velocities are 37, 56 and 62mm/yr westward, respectively, showing an increase to the north. We confirm that the Sundaland margin stretches to the Molucca Sea and the Philippine deformation belt rotates counter-clockwise.

To estimate subduction style in the Moluca Sea, we used seismicity and gravity anomaly data in addition to the GPS velocity field. While a westward dipping slab exists in the northern part of the Moluca Sea, two main slabs that dip to the east and the west exist in the southern part. The subduction style in the Moluca Sea shows large variability from north to south.

Location of Tremor Sources at Aso Volcano Using Short Period Seismic Array

N. Takagi, S. Kaneshima, T. Mori, M. Yamamoto, H. Kawakatsu,
T. Ohkura , Y. Sudo, S. Yoshikawa** and **M. Sako

The sources of short period volcanic tremors at Aso Volcano are located using seismic array data. There are two types of short period volcanic tremor at Aso Volcano: continuous tremor and isolated tremor. The continuous tremor is ground vibration with approximately constant amplitudes without any clear beginning and end. An isolated tremor is, on the other hand, an episodic event which starts suddenly and continues about ten seconds. Short period seismometer arrays are deployed for three days near the crater of Aso in 1999 and 2001, and the short period volcanic tremors were recorded. In order to locate these volcanic tremors we develop two semblance-based seismic array analysis methods: one method which stacks semblance coefficients for many individual time windows, and another which stacks seismogram s of the individual seismic stations over different time windows and computes semblance coefficients for the stacked seismograms. A technique is also developed to utilize three-dimensional particle motions and to extract episodic events with the same pattern of ground motions.

Based on the results from the array analyses we conclude that the continuous tremor in 1999 consists of surface waves which are emitted from the vicinity of the western rim of the active crater at very shallow depth, probably shallower than 200 meters from the surface of the crater lake. On the other hand, the isolated tremor in 1999 is S wave (body wave) whose source is located south of the crater. The epicenter of isolated tremor is, however, poorly constrained because of small array apertures relative to its wavelength and its large apparent velocity. Its focal depth also is difficult to determine, but it is almost certainly deeper than that of the continuous tremor. The estimate of the depth is 500 (+- 500) meters from the surface of the crater lake. There aren't large changes in the location of the tremors during a year and half between the two observations, in November 1999 and July 2001. We also find that each isolated tremor event consists of two subevents separated nearly 1.2 seconds in time, with the latter subevent always having lager amplitudes. These location techniques, however, cannot discriminate the foci of the two subevents. Such a synchronized occurrence of two events should provide an important clue in understanding the mechanism of excitation of the isolated tremor.

Escape of volcanic gas into shallow groundwater systems at Unzen volcano (Japan): Evidence from chemical and stable carbon isotope compositions of dissolved inorganic carbon

S. Ohsawa, K. Kazahaya, M. Yasuhara, T. Kono, K. Kitaoka, Y. Yusa and K. Yamaguchi

Chemical and stable carbon isotopic analyses of dissolved inorganic carbon (DIC) were carried out for groundwater samples collected from cold springs and shallow wells in Unzen volcanic region in 1999 and 2000. All of the data sets plotted on the $\delta^{13}C$ vs. 1/DIC diagram can be explained by mixing of volcanic CO_2 with DIC equilibrated with soil CO_2. Groundwater DIC showing a high mixing ratio of volcanic CO_2 appears to have a tendency to distribute along two major faults nearby the activity center of the 1990-1995 eruption. This suggests that these faults are escape routes of volcanic CO_2 diffused into volcanic edifice. Total flux of the volcanic DIC discharged from the cold springs is shown to be one to two orders of magnitude lower than the roughly estimated flux of volcanic CO_2 discharged from the summit during the eruptive period.

(Submitted to Limnology)

Geochemistry of Fluids from Hot Springs, Mineral Springs, Wells and Fumarolic Area in the Shimabara Peninsula, Middle Western Kyushu, Japan

S. Ohsawa, K. Kazahaya and M. Yasuhara

Water and gas samples from hot springs, mineral springs, wells and fumarolic area in the Shimabara Peninsula, middle western Kyushu, were collected for chemical and isotopic analyses. Geochemical data analyses lead us to the following results. Hot spring water of acid SO_4 type in Unzen-Jigoku fumarolic area is derived from meteoric shallow groundwater heated up to 150℃ by secondary steam originated from deep hydrothermal water of about 300℃. Thermal water of Cl type in Obama area, which is basically mixture of seawater and shallow groundwater of meteoric origin, interacts with reservoir rock at about 200℃. The thermal water in the reservoir is heated by steam of about 300℃ containing magmatic He and CO_2. Thermal waters of HCO_3 type in Shimabara and Harajo areas are slightly heated groundwater of meteoric origin. However, it is detected that magmatic CO_2 is dissolved in the thermal waters. Both thermal waters from Mizuho and Yue, which are classified chemically into Cl-HCO_3 mixed type and HCO_3 type, respectively, are likely to be non-volcanic formation waters. The accompanying methane gases with these waters have thermogenic and biogenic origins, respectively. Mineral water of Cl type from Karako may be mixture of seawater and meteoric groundwater, and is not affected by magmatic emanation. Mineral water of HCO_3 type from Karimizu in Obama area is originated from meteoric water, but the accompanying gas with strong H_2S smell would be derived from the reservoir of the Obama thermal water.

(Submitted to J. Balneol. Soc. Japan)

The Petrology and Geochemistry of High-Mg Andesites at the Western Tip of the Setouchi volcanic belt, SW Japan

Y. Tatsumi, H. Shukuno, K. Sato[1], T. Shibata and M. Yoshikawa
(1: JAMSTEC)

K-Ar ages, petrographical and geochemical characteristics of high-Mg andesites andplagioclase-phyric andesites in the NE Kyushu region are presented. K-Ar ages obtained for those rocks, ranging from 10.7±0.3 to 14.4±0.4 Ma, overlap those reported for lavasof the Setouchi volcanic belt in other regions (11-16 Ma). This, together with major, incompatible trace element, and Sr-Nd-Pb isotopic characteristics, confirms that the Setouchi volcanic belt, which is characterized by the occurrence of high-Mg andesites, extends for ~600 km along the SW Japan arc, to the north of the Shikoku Basin formed immediately before the Setouchi magmatism. Subduction of a young hence hot lithosphere of the Shikoku Basin may account for the production of unusual high-Mg andesite magmas in the volcanic belt. Two types of high-Mg andesites, both possessing identical bulk rock compositions, are recognized: one contains olivine phenocrysts and chromian spinel inclusions showing compositional characteristics consistent with their crystallization as liquids phases, whereas the other contains nikeliferous and Fe-rich olivine and Fe3+-rich spinels. One of the possible causes for such unusual compositions of constituent minerals would be effective elemental diffusion within and through olivine crystals associated with the long residence time and the slow rate of cooling of magmas. The compositions of liquidus chromite and olivine, as well as major element compositions, may suggest that such HMA magmas may have been produced by higher degrees of partial melting than those in other regions of the Setouchi volcanic belt.

(Submitted to Jour. Petrol.)

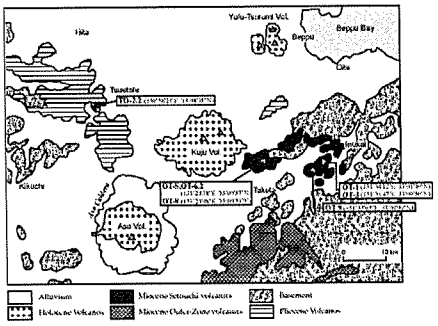


Fig. 1. Distribution of Cenozoic volcanic rocks in the NE Kyushu region (after Kamata, 1985). Sampling localities (stars) and their longitudes and latitudes are also shown. Five samples collected from Miocene lavas and a dyke, and one sample (TO-2.2) from Pliocene volcanics

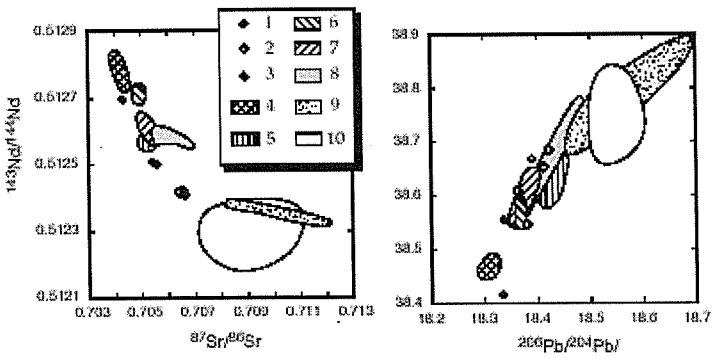


Fig. 2. Isotopic compositions of Setouchi volcanic rocks, terrigenous sediments at Nankai Trough, and basement rocks in the NE Kyushu and other regions. The Quternary andesite TO-2.2 possesses more depleted Sr-Nd isotopic signatures than lavas from the SVB. Plagioclase-phyroc andesites exhibit more enriched Sr-Nd-Pb isotopic characteristics than HMAs in the NE Kyushu regions, as well as other regions of the SVB.

Three-Dimensional Seismic Velocity Structure beneath Aso Volcano

Y. Sudo and L.S.L. Kong

Tomographic results for P and S wave velocity structure beneath the active Aso Volcano, Kyushu, Japan, using 800 well-recorded earthquakes and 10 shots recorded by a 8-station seismic network, are presented. A 68 % variance reduction was achieved upon simultaneous inversion for hypocenter and velocity structure. Well-resolved velocity anomalies associated with the active crater reveal heterogeneity up to 26 % slower and 18 % faster in P velocity, and up to 31 % slower and 22 % faster in S velocity, than the one-dimensional model. The largest anomaly is seen over the upper 11 km in the central and northern parts beneath the central cones. Two low velocity regions are imaged. The first, a 10 by 15 km region encompassing the upper 3 km centered near the caldera wall at Tateno Valley, is characterized by P velocities up to 19 % slower (20 % for S). The second low velocity region is associated with the central cones and active magma conduit system at 6-km depth. Velocities as low as 4.3 km/s (up to 26 %) in P and 2 km/s (31 % slower) in S characterize the 7-km wide volume. The magma chamber is roughly spherical in shape, centered at 6-km depth, flattens at 10-km depth, and located between Mt.Kishima, Mt.Eboshi, and Mt.Naka, the present locale of magmatism. A sharp velocity contrast at the depth of 3 km, with high velocities to the southwest and lower velocities to the northeast, characterizes different abutting structures associated with the Oita-Kumamoto Tectonic Line.

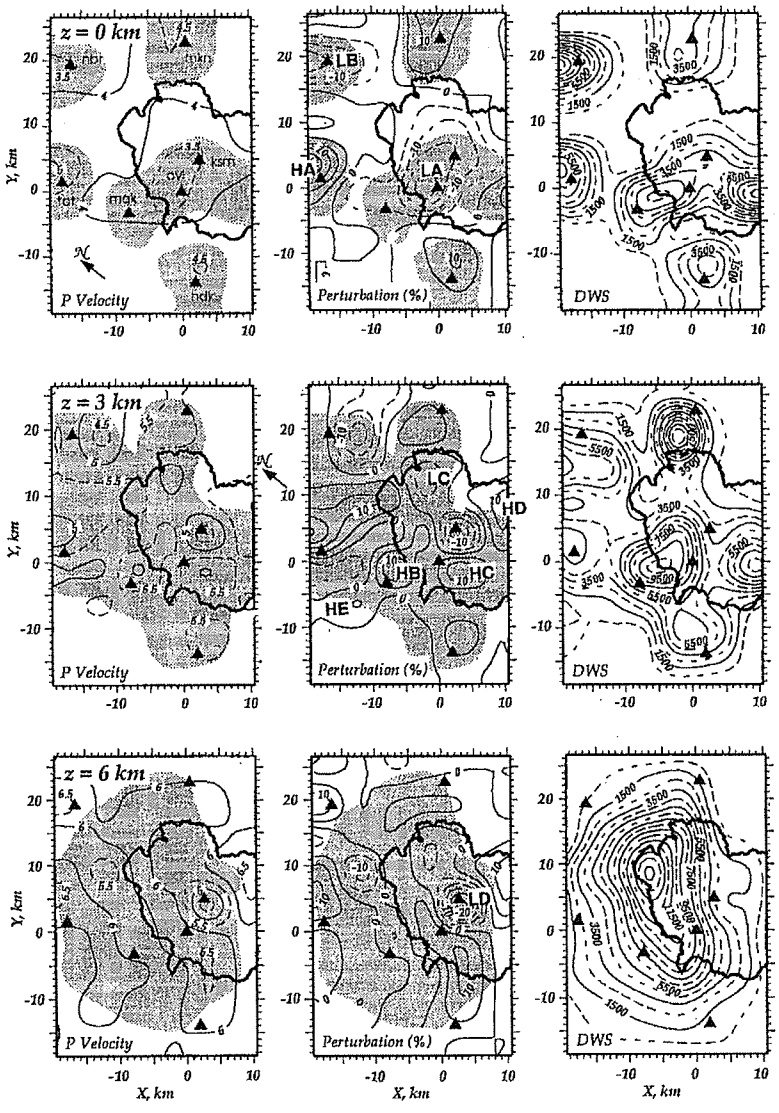


Fig. 1. Horizontal P wave sections for the study region; velocity resolution over the entire study area is very good for depths slices at 3 and 6 km. Triangles show the locations of the seismic stations used to locate the earthquakes (station names shown on Z = 0 km section). A heavy solid line delineates that outline of the caldera. Stippled areas show the regions where velocity is well-resolved (DWS $\geqq$ 1500). Velocity and DWS are contoured at 0.5 km/s and 1000 km intervals, respectively. Perturbations are contoured at 5 % intervals with solid lines indicating positive values,or velocities faster than the average model, and dashed lines indicating negative values, or velocities slower than the average model. Main lower velocity anomalous regions are indicated as LA, LB,LC,LD, and LE, and higher regions as HA, HB, HC, HD, and HE.

New Active Fault descried in Aso Caldera and Seismic Activity

Y. Sudo and S. Ikebe

Recently, in Aso Caldera, the new active fault has descried, of which the strike is N60E, the dip angle is 60, and the displacement is 1m. From the stratigraphic tephras, this fault was active at the time less than 1000 years. At the same district, many seismic events have been observed and the distribution of epicenters consists with the fault strike.

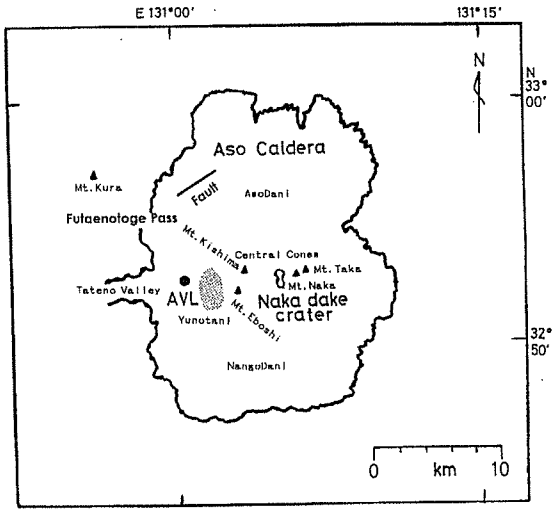


Fig. 1 Map of Aso Caldera. The active fault descried in Aso Caldera is indicated with a cross mark.

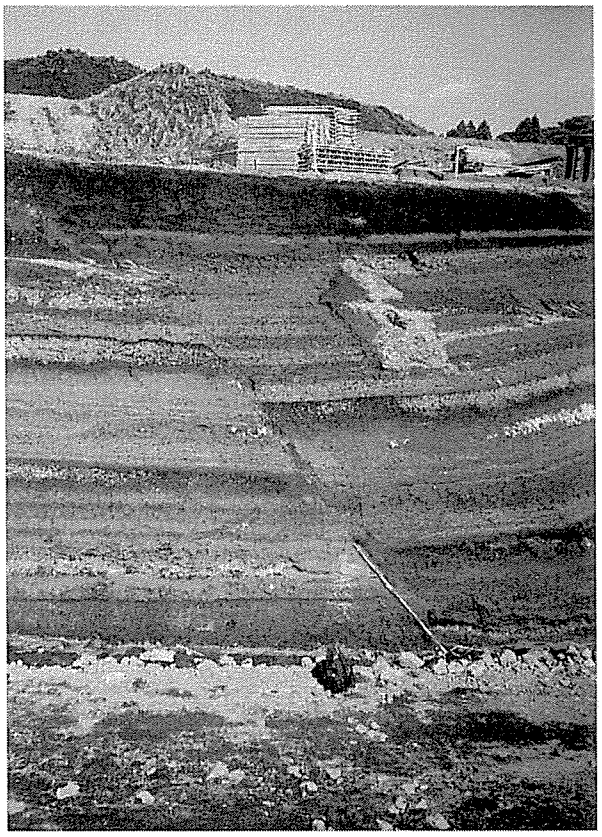


Fig. 2 Photo of the active fault descried in Aso Caldera.

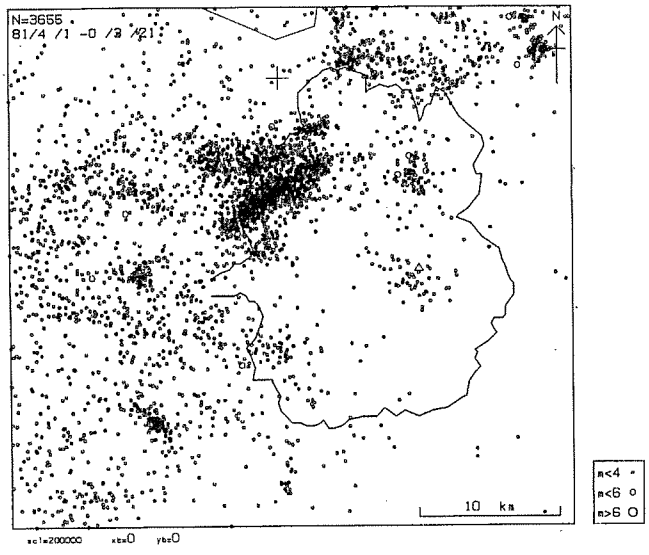


Fig. 3 Epicenter distribution of earthquakes which occurred in and around Aso Caldera during the period from 1981 to 2000.

Spectral Characteristics of Volcano-tectonic Earthquake Swarms in Nevado del Ruiz Volcano, Colombia

J. M. Londono and Y. Sudo

Spectral analyses for volcano-tectonic earthquakes were carried out at Nevado del Ruiz Volcano(NRV)for the period 1985-1996 for several earthquake swarms around the volcano, named North, East, South and Crater swarm zones. Important spectral peaks for each earthquake were found by counting the number of spectra that had the same spectral peaks. Each swarms zone showed some characteristic peaks, which could help to differentiate between them: however, the most important peaks were similar for all zones. There results suggest that the earthquake swarms at NRV were influenced directly by the source (activity of the volcano) and could also be influenced by the site effect. Some temporal changes were observed in spectral parameters such as a change in the frequency contents in almost all the swarm zones, and the frequency of the P-waves in the West earthquake swarm zone. Before the eruptions on November 13, 1985 and September 1, 1989, P-waves showed low frequencies (1-2 Hz) at the West earthquake swarm. After the eruptions, the frequencies of P increased (2-4 Hz). This fact showed that changes (decreasing of frequencies) in the spectra of P-waves at the West earthquake swarm could help in the monitoring of volcanic activity at NRV. This swarm zone seems to be related directly with the most important volcanic crises that have occurred. This suggests that the West swarm zone should be more in the future.

Re-Os isotopic systematics of the Taklimakan Desert sands, moraines and river sediments around the Taklimakan Desert, and of Tibetan soils

*Y. Hattori, **K. Suzuki**, M. Honda and H. Shimizu*

We report here the first Os isotopic ratios and abundances of Os and Re for Taklimakan Desert sands and glacial moraines from the Kunlun Mountains. Osmium isotopic data are also reported for river sediments around the Taklimakan Desert, river sediments from the Kunlun and Tianshan Mountains, Tibetan soils and loesses from the Loess Plateau, as well as Sr and Nd isotopic data for these samples. The Taklimakan Desert sands show extremely homogeneous Os isotopic ratios and abundances, with some variation of Re abundances. The $^{187}Os/^{188}Os$ ratio of 1.3 for the Taklimakan Desert sands is close to the average for Kunlun and Tianshan moraines, river sediments around the Taklimakan Desert and Tibetan soils. This result supports the idea that the Taklimakan Desert sands are derived from moraines and river sediments around the Desert and/or from Tibetan soils.

In contrast to the small difference in Os isotopic data between the Taklimakan Desert sands ($^{187}Os/^{188}Os$ =1.3, this study) and loess ($^{187}Os/^{188}Os$ = 1.05; Peucker-Ehrenbrink and Jahn, 2001) from the Loess Plateau, Os abundances and $^{187}Re/^{188}Os$ ratios exhibit large differences: approximately 10 ppt Os with $^{187}Re/^{188}Os$ ratio ranging from 60 to 160 for the desert sands (this study), and approximately 30 ppt Os with $^{187}Re/^{188}Os$ ratio of 35 for loess (Peucker-Ehrenbrink and Jahn, 2001). It is suggested that grain-size sorting during aeolian transport of the Taklimakan Desert sands results in enrichment of the fine fraction, whereby mafic minerals with high Os contents and low $^{187}Os/^{188}Os$ ratios show higher contents in loess. The $^{187}Os/^{188}Os$ ratios ranging from 1.0 to 1.3 and the 1.6 Ga Nd model age of the Taklimakan Desert sands and loess suggest that a reasonable $^{187}Re/^{188}Os$ ratio for the 2.2 Ga upper continental crust is 35. Our Re-Os data for the Taklimakan Desert sand, moraines and river sediment around the Taklimakan Desert and Tibetan soils were compared with those of loess from the Loess Plateau and it was concluded that the Re-Os data of the loess can be used as proxy of the upper continental crust.

Re-Os isotopic characters of ocean island basalts from Tubuai, Polynesia.

*M. Honda, **K. Suzuki**, Y. Tatsumi*

The linear chains of volcanic islands of Polynesia trend southeast to northwest. This linear trend is one of the basis of the idea that ocean-island-basalts (OIBs) of Polynesia have been originated from a common mantle plume. However, Sr-Nd-Pb isotopic compositions of OIBs of Polynesia show very large and unsystematic variation. Basalts from Tubuai Island in the Austral archipelago of Polynesia show Sr-Nd-Pb isotopic characters like HIMU which is one of the end members of Earth's mantle (Chauvel et al., 1992; Vidal et al., 1984). In this study, we characterize Re-Os isotopic composition of basalts from Tubuai and then examine the forming process of the Tubuai basalts.

Basalts from Tubuai display large variation in Os abundance (5.0-1268ppt) and $^{187}Os/^{188}Os$ ratio (0.1418-0.2729). Samples with relatively low-Os-abundance (5.0-7.3ppt) samples show high $^{187}Os/^{188}Os$ ratio (0.2450-0.2729), which may be due to assimilation of crustal materials altered by sea water (Marcantonio et al., 1995). Samples with relatively high Os abundance

(29-174ppt) exhibit a limited range of $^{187}Os/^{188}Os$ ratio (0.1703-0.1761), which is clearly higher than commonly accepted HIMU mantle $^{187}Os/^{188}Os$ ratio (0.155; Hauri and Hart, 1993). We maintain that the $^{187}Os/^{188}Os$ ratio of approximately 0.17 obtained in this study should be accepted for HIMU mantle $^{187}Os/^{188}Os$ ratio.

Re-Os isotopic composition of loess from the Yili Basin, China

*M. Honda, S. Yabuki, **K. Suzuki**, Ye, Kanayama, Y. Tatsumi*

Geochemical and isotopic data of loess are valuable to estimate chemical and isotopic composition of average upper continental crust and also to trace material transport processes on the Earth's surface. Rhenium-osmium isotopic signatures of loess may give new information on source and sedimentary process, because differentiation of Re-Os during partial melting and fractional crystallization is clearly larger than that of Rb-Sr or Sm-Nd. However, little Re-Os isotopic data of upper crustal materials including loess have been reported because of their extremely low Os abundance (a few ppt to sub-ppt). To examine whether the Re-Os isotopic composition of loess represents that of an average upper continental crust and also examine what process (e.g., weathering or variations in source) best correlates to Re-Os isotopic variation of loess, we have measured Re-Os isotopic composition of loess and paleosol samples which was systematically collected in the Yili Basin, northwestern China with varying depth (1.0-16.6m).

Loess and paleosol samples display the homogeneous $^{187}Os/^{188}Os$ ratios ranging from 1.214 to 1.308, which is almost within analytical errors (2σ). Variations in Re (167-851ppt) and Os (59-50ppt) are relatively larger in the lower part (7.8-16.6m depth) than in upper part (1.0-5.0m depth). Therefore, Re and Os abundance may be more sensitive to variations in source and pedogenesis of loess than $^{187}Os/^{188}Os$ ratio.

The $^{187}Os/^{188}Os$ ratios of loesses and paleosols from the Yili Basin is higher than $^{187}Os/^{188}Os$ ratio of loess from the Loess Plateau (0.875-1.209; average 1.04) reported by Peucker-Ehrenbrink and Jahn (2001). This difference possibly resulted from the local difference in $^{187}Os/^{188}Os$ ratio among sources of Chinese loess.

Behavior of platinum group elements in the ocean island basalts from Polynesia

*K. Shinotsuka, **K. Suzuki**, M. Honda, **G. Shimoda**, Y. Tatsumi*

Platinum group elements (PGEs; Os, Ir, Ru, Rh, Pt and Pd) provide a key information to understand deep mantle processes, because PGEs are highly siderophilic and rarely contained by crustal rocks. So far, many analyses of PGEs in peridotites have been carried out to establish whether upper mantle materials have chondritic PGE abundance ratios. On the other hand, it has been recognized that some ocean island basalts (OIB) have elevated $^{187}Os/^{188}Os$ ratios compared with those in chondrites. It has been debated whether the elevated $^{187}Os/^{188}Os$ isotopic ratios were due to the recycling of ancient oceanic crusts or the entrainment of the earth's outer core material having high Re/Os ratio to the plume. Recently, Brandon et al.

(1999) found that the $^{186}Os/^{188}Os$ ratios of Hawaiian picrites, where ^{186}Os was decayed from ^{190}Pt, were positively correlated with $^{187}Os/^{188}Os$ ratios, suggesting that the latter is more likely and Hawaiian plume was derived from the core-mantle boundary. In line with their work, we are applying ^{190}Pt-^{186}Os isotopic systematics to the OIBs derived from HIMU type source (high $^{238}U/^{204}Pb$), which is the candidate of the deepest mantle products, in Polynesia.

PGE abundance in OIBs has been little reported so far, because the abundance of Os, Ir, Ru are 1-2 order lower than that of peridotites. Tatsumi et al. (2000) reported that PGE abundances in HIMU basalts from Polynesia decreased with increase in the degree of fractional crystallization of the basalts and the correlation among them was not observed in non-HIMU basalts. This was explained that HIMU magma was saturated with sulfur but not non-HIMU magma. Sulfides should be crystallized collecting PGEs in their crystals.

In this study, we aimed to confirm that sulfur-saturation is characteristics of HIMU magma at first and, second, to examine the possibility that PGE abundance in OIBs is applicable to characterize OIBs derived from the other types of geochemical reservoir. PGE abundances of the samples were determined using the slightly modified method established by Oguri et al. (1999). Before the Polynesian OIBs are analyzed, some basalt and pridotite geological standard rocks (JP-1, JP-1, BHVO-2, BCR-2, DTS-2) are analyzed to evaluate the reliability of this technique in the sample with low PGEs such as basalts. We will further apply it to the Polynesian OIBs.

Osmium isotopic compositions of mantle xenoliths in east China: Implications for continental lithospheric mantle beneath China

K. Suzuki, X. Li and M. Ebihara

Geochemical and isotopic data on mantle peridotite xenoliths provide key constraints on the evolution of lithospheric mantle beneath the thick continental crust. Here we report both Re and Os abundance and Os isotopic compositions of 13 peridotite xenoliths collected from Cenozoic continental basalts which are widely distributed in eastern China.

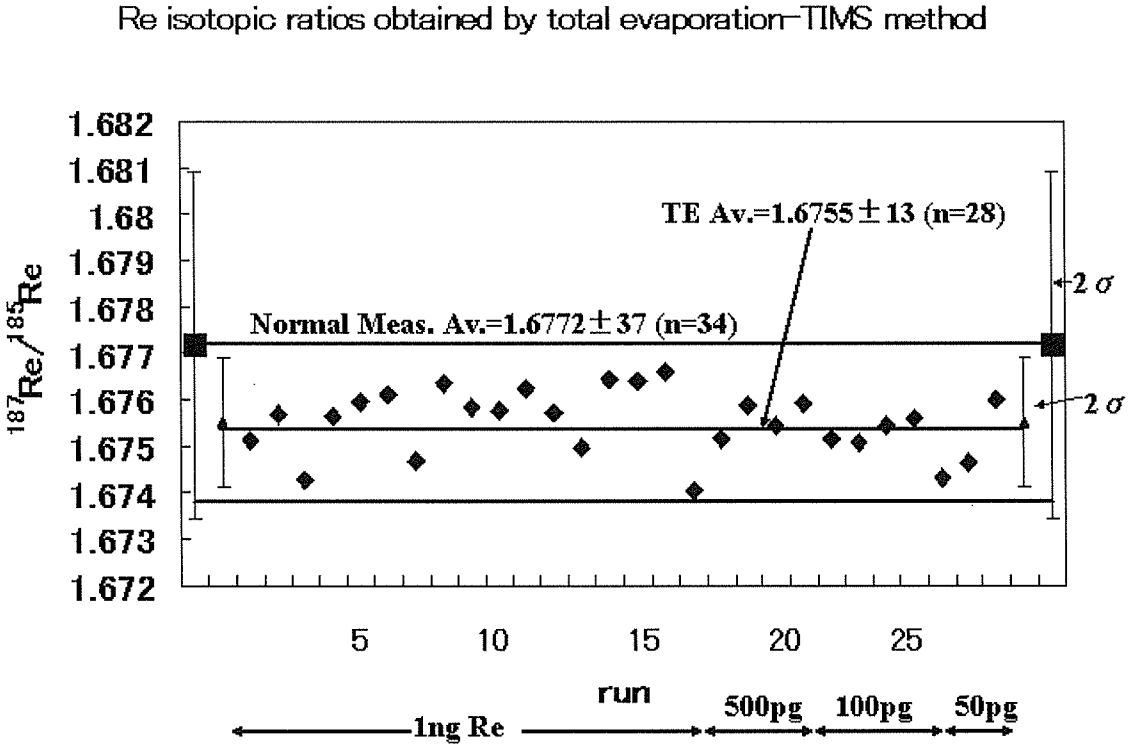
Re and Os abundance obtained for the xenoliths range from 30 to 350 ppt and from 600 to 4750 ppt, respectively. The $^{187}Os/^{188}Os$ ratios of these samples range from 0.1140 to 0.1391. The xenoliths except for garnet lherzolites form positive correlation in $^{187}Os/^{188}Os$ vs. Al_2O_3 space. The Al_2O_3 content is one of the depletion factors for peridotite. Results also show an intercept of $^{187}Os/^{188}Os$ ratio at the fertile Al_2O_3 content of 4.2% (w/w) is 0.1300, which is in the range of those of the global primitive upper mantle (0.1296 +/- 0.008, Meisel et al., 2001). The $^{187}Os/^{188}Os$ ratio obtained in this study likely represents the $^{187}Os/^{188}Os$ of the lithospheric mantle beneath China. On the basis of the Re depletion model age of the y-axis intercept in the Al_2O_3 - $^{187}Os/^{188}Os$ diagram, a kind of initial $^{187}Os/^{188}Os$ of the xenoliths from eastern China is 0.1144, which results in the Re depletion age of 1.9 Ga. The depletion ages obtained by Meisel et al. (2001) and in this study range from 1.9 Ga to 1.3 Ga. The intense melt depletion and formation of sub-continental lithospheric mantle recorded in these suites could be the consequence of an important continental crust–forming period, which may be inconsistent with some estimates of continental crust growth (>2.0Ga).

Rhenium isotope ratio measurements by negative thermal ionization mass spectrometry (TIMS) using total evaporation technique

K. Suzuki and Y. Miyata

Rhenium isotope ratio, $^{187}Re/^{185}Re$, has been determined by negative thermal ionization mass spectrometry using the total evaporation technique. The advantages of the total evaporation method are two folds. 1) The mass discrimination for elements with only (merely) two isotopes cannot be internally corrected. The total evaporation technique could make the correction unnecessary. 2) The short measurement time. The average $^{187}Re/^{185}Re$ ratios obtained for 50 pg - 1 ng Re standard using the total evaporation is 1.6755 +/- 13 (2-sigma = 0.0804 %, n=28), which is closer to the $^{187}Re/^{185}Re$ ratios of IUPAC (1.674) than the ratio obtained by the normal isotopic measurements (1.6853 +/- 38, n=34). Additionally, the error in the total evaporation measurement is smaller than those in the normal measurements. The total evaporation could provide more accurate and precise isotopic ratios of the elements with two isotopes.

The average isotope ratio is 0.1029 % higher than that calculated from the IUPAC data. Therefore, using the bias of 1.001029 as a correction factor, the accurate Re isotope ratio with high precision of less than 0.1 % can be obtained.

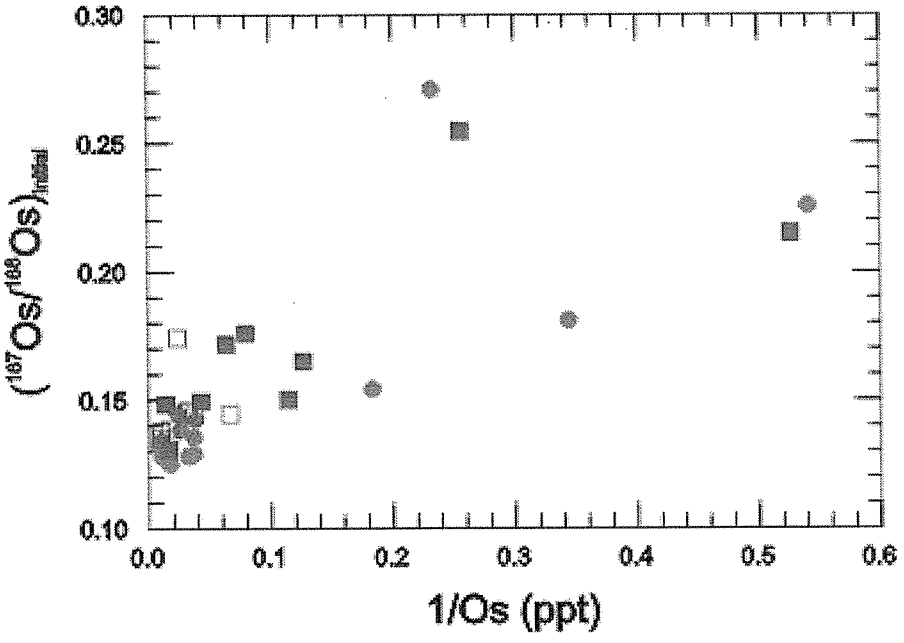


Osmium isotopic signature of EM1 deduced from Rarotonga Island, Polynesia

K. Suzuki, G. Thompson, Y. Tatsumi and M. Honda

The geology of French Polynesia (i.e., the South Pacific Superswell) is a distinctive region that has generated considerable debate on the causes of ocean island volcanism and, by extension, mantle dynamics and the existence or non-existence of mantle plumes. Rarotonga (Cook/Austral chain) and Pitcairn Island (Gambier chain), separated by approximately 1200 km, are distinct in the South Pacific in that they both have an EM1 mantle component. Here we present new Os data for Rarotonga and, in conjunction with published isotopic data, present a revised value of the EM1 osmium signature.

Osmium concentrations in lavas range from 2 to 126 ppt and are typical of those found in ocean island basalts (OIB). The measured Os isotope ($^{187}Os/^{188}Os$) compositions range from 0.129 to 0.277. When $^{187}Os/^{188}Os_{initial}$ and 1/[Os] are compared, they form a broad positive array and samples with higher Os concentrations (> 25 ppt) show a limited range of $^{187}Os/^{188}Os$ ratios (mean = 0.133 ± 0.006), while those with low Os (< 25 ppt) display variable and relatively radiogenic Os isotopic compositions ($^{187}Os/^{188}Os_{initial}$ = 0.129 - 0.271). This increase of radiogenic Os with decreasing Os concentrations in OIB has been ascribed to assimilation of a radiogenic component by a melt in the crust or lithosphere or by mixing between radiogenic and unradiogenic mantle components. It is clear that Rarotonga (this study) and Pitcairn (Eisele et al., 2002) have virtually identical Os isotope signatures. These values also concur with their argument that previously accepted values for EM1 of $^{187}Os/^{188}Os$ = 0.15 (Reisberg et al., 1993; Schiano et al., 2001) are too high and are probably due to shallow level processes. Therefore a more realistic value of 0.13 should be accepted for EM1. Our data suggests that the Os isotopic signature of Cook-Austral can be explained by mixing between EM1 and HIMU, which is inconsistent with the conclusion by Schiano et al. (2001) that the island chain shows the mixing of Bulk Silicate Earth and HIMU.



We also propose a new model for the South Pacific Superswell, combining mantle tomography and geochemistry that unifies the hotspot theory both for the origin of plumes in the lower mantle and upper mantle, the wetspot theory and a lithospheric mechanism.

Identification of multiple faulting of the Median Tectonic Line active fault system in the Tokushima Plain based on high-resolution sedimentological analysis

*T. Nakanishi, **K. Takemura,** A. Okada*, et al.

The Median Tectonic Line (MTL) active fault system is a 300-km-long, arc-parallel, right-lateral strike-slip fault related to oblique subduction of the Philippine Sea plate beneath the Eurasian plate at the Nankai trough, southwest Japan. High-resolution sedimentological analysis of core samples from the Tokushima Plain <Shikoku Island> enables us to identify evidence for multiple faulting of the MTL during Holocene time. The continuous and close-interval analyses of lithology (cm-order) and magnetic susceptibility (2cm-interval) were carried out on three core samples from the hanging wall and footwall sides of the Naruto-minami fault which is a part of the MTL. In addition, analyses of grain size (10cm-interval) and composition of very fine sand fraction (20cm-interval) were carried out on core samples obtained at both ends of the fault deformation zone. Based on these sedimentological analyses, we correlated 34 horizons across the boreholes and divided the strata into 8 sedimentary units. We also identified 6 intervals that are thicker on the footwall side of the fault. These intervals appear to be related to movements of the MTL and the age of these paleoseismic events are estimated based on radiocarbon ages. At least 6 paleoseismic events are detected during the last 18000 years : 1515~1700 cal BP, 2000~2900 cal BP, 3000~6000 cal BP, 7300~7500 cal BP, 8800~9100 cal BP, 9500~18000 cal BP. The average dip slip rate of the Naruto-minami fault is estimated at 1.0 mm/year.

(Journal of Geography)

Active Tectonics and Basin Formation in the Osaka Sedimentary Basin, Southwest Japan at a Contractional Bend of a Large Transcurrent Fault

***K. Takemura,** Y. Itoh, S. Kusumoto, **N. Inoue** and N. Kitada*

Southwest Japan is considered in the area under the east-west compressional stress state from the geophysical, topographical and Quaternary geological information. The forces from Pacific Plate and oblique subduction movements of Philippine Sea Plate influence the Kinki district in southwest Japan. Active faults are densely distributed in the Kinki district, and one of them was reactivated in 1995, and we suffered much amount of damages in Kobe and its vicinity (1995 Kobe Earthquake). This fault system runs at the northern part of the Osaka Sedimentary Basin including Osaka and Kobe area, the second large urban area in Japan.

Osaka Sedimentary Basin is located at the easternmost left stepping bend of the dextral Median Tectonic Line (MTL), a fault system activated throughout the Quaternary time with right lateral strike slip movements of E-W direction. Right lateral strike slip fault named as Arima-Takatsuki Tectonic Line (ATTL) runs at the northern end of the Osaka Sedimentary Basin. Basin formation process of Osaka Sedimentary Basin is explained as the activity of right-lateral left stepping faults (MTL and ATTL) and the secondary reverse fault activity by means of the dislocation modeling.

Many subordinate faults in the basin accommodate compressive stress, whereas differential vertical motion of fault-bounded blocks results in complex sedimentation. We summarized stratigraphic information of late Pliocene to Pleistocene Osaka Group of core samples. On the basis of magnetostratigraphy, tephrostratigraphy and paleoenvironmental analysis, 15 datum horizons of transgression, which are recognized as bases of marine clays (Ma-1 to 13), are assigned to the

oxygen isotope stages. Subsidence rates and temporal changes visualize differential subsidence at each fault-bounded blocks. Osaka-wan fault, which runs parallel to the earthquake fault of Kobe Earthquake with NNE-SSW direction in the Osaka Bay, gives an important role for the differential subsidence in the Osaka Sedimentary Basin.

Late Quaternary Vertical Displacement of Osaka-wan Fault on the Basis of Correlation of Drill Cores, Central Japan

K. Takemura, N. Kitada, Y. Itoh, et al.

The 40km-long Osaka-wan fault is one of the major active faults in the Osaka district, central Japan. The Japan Coast Guard conducted drillings on both sides of the Osaka-wan fault and obtained about 100m-long OB-1 and OB-2 cores after the 1995 Hanshin-Awaji great earthquake. We carried out detailed stratigraphic and paleoenvironmental studies of the two cores including initial magnetic susceptibility measurement, tephra analysis, microfossils identification and pollen analysis in order to correlate the cores and estimate the activity of the Osaka-wan fault. As a result, three marine clay beds separated by non-marine deposits have been recognized beneath the Ma13 (Holocene marine transgressive sediments of Marine Isotope Stage 1). The lowest marine clay bed recognized at the basal part of the OB-1 core (hanging wall side) has been correlated by pollen analysis to the Ma12, a marine clay bed deposited in the Marine Isotope Stage 5e of the Last Interglacial Time. The presence of two marine clay beds between the Ma13 and Ma12 indicates two transgression events in the latter half of the Last Interglacial Stage. 25ka AT and about 100ka Ata tephras were found respectively in the non-marine deposits beneath the Ma13 and in the upper marine clay bed between the Ma13 and Ma12. The average vertical slip rate of the Osaka-wan fault has been estimated at about 0.3 m/ky from the depths of these tephra layers on both sides of the fault.

Holocene Sea-level Changes Around the Japan Sea Inferred from Borehole Survey in the Mawaki Archaeological Site, Central Japan

Y. Itoh, K. Takemura, T. Nakamura et al.

A Holocene relative sea-level curve is generated on the basis of geologic data in the Noto Peninsula, central Japan. Among 17 boreholes drilled in the Mawaki archaeological site, we select four from which lithologic and / or chronological data are reported. Initial magnetic susceptibility is utilized for correlation of core samples with an assistance of radiocarbon ages. Four lithologic units are identified and interpreted as a sequence in a cycle of marine transgression and regression. Dated coastal horizons are picked-up to indicate former sea levels. Since hydro-isostatic and tectonic effects are moderate in the study area, rapid rise during 7000-6000 yBP (8000-7000 cal BP) and succeeding minor fall (ca. 5000 yBP <6000 cal BP>) of sea levels basically signify eustatic trend around the Japan Sea.

(Submitted to Holocene)

Aeromagnetic survey in Kuchierabujima-Island Volcano.

M. Utsugi, Y. Tanaka, W. Kanda and T. Matsushima

To investigate the magnetic structure of the Kuchierabujima-Island Volcano, we conducted the aeromagnetic surveys using helicopter in January of 2001. We measured along 18 parallel N-S lines with 250m spacing and 10 parallel E-W lines with 500m spacing over and around the Eastern part of Kuchierabujima-Island Volcano (Fig. 1) using portable Overhauser effect magnetometer. The altitude of flight was kept about 200 to 300 m above the terrain for N-S lines, and constant altitude (about 800m) above the sea level for E-W lines, respectively.

To determine the distribution of rock magnetization, we divided the crust with a number of cubic blocks (length=250m, width=250m and height=5,000m). Using the joint inversion of the observed data and the topography, we determined the intensity of the magnetization of each cubic block. The effect of the topography is corrected from a digital terrain model by integrating analytically in the vertical direction and then numerically in horizontal plane.

The distribution of the surface magnetization around Furudake and Shindake crater is shown in Fig.2. One of the low magnetized areas (hatched area) is shown in the southeastern area of Shindake crater. From the GPS measurements on and around Kuchierabujima-Island (Iguchi et al., 2002), the positive dilatation was found and the estimated horizontal location of the center of dilatation is good match with the location of low magnetization area. Then these low magnetization area may be able to affiliate to the Volcanic sources such as magma chambers.

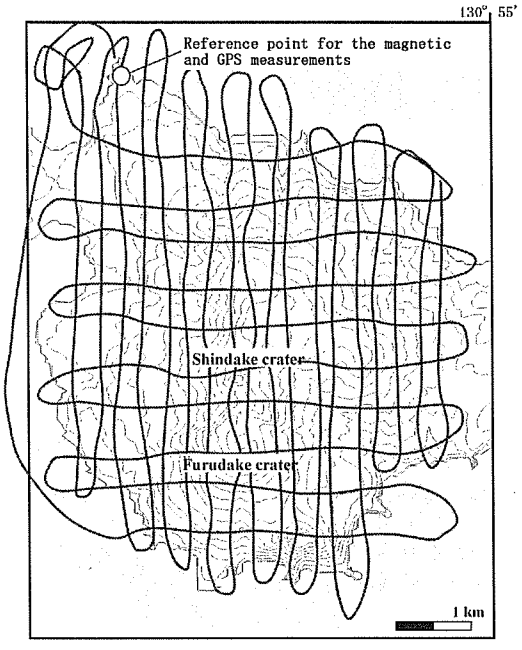


Fig. 1 Flight course of aeromagnetic survey

Fig. 2 Distribution of the surface magnetization around Furudake and Shindake crater.

Installing piezometers for observation of groundwater flow in the river bed

M. Yamada, H. Mawatari and Y. Yusa

Piezometers have been installed into the river bed in the Oita River, Yufuin Basin, to measure hydraulic heads of the groundwater and also to collect groundwater samples for chemical analysis.

The piezometer consists of an acrylic pipe with a screen at the bottom part (Fig.1). The screen is wrapped with a nylon mesh net, which prevents the screen from plugging by inflow of sediment. A rubber-ring equipped at the upper side of the screen expands by sucking water to prevent from influx of water coming from above along the outside of the piezometer wall. Figure-2 shows the method of installation of the piezometer. (1) An iron casing pipe equipped with a bolt at the bottom is driven into the river bed by a hammer. (2) When the casing pipe reaches a desired depth, the piezometer is inserted to be held in place. (3) The casing pipe is pulled out.

The piezometers at a depth ranging from 1m to 3m have been set in 9 places (totally 34 piezometers) along a river section of about 2 km of the Oita River.

It is expected that measurement of hydraulic head and chemical compositions of groundwater collected from these piezometers will provide valuable information on interaction between groundwater and river water.

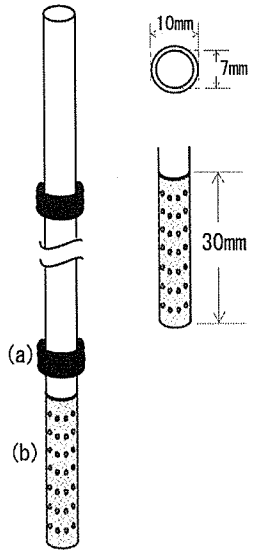


Fig. 1 Design of piezometer
(a) : A rubber-ring expands by sucking water.
(b) : The screen has a lot of hole and is wrapped with nylon mesh net.

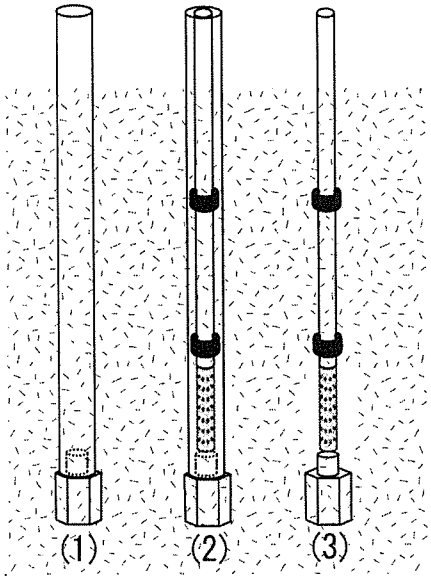


Fig. 2 Method of installation of piezpmeter
(1) Casing pipe driven into the sediment by a hammer.
(2) Piezometer is inserted to be held in place.
(3) Casing pipe is pulled out..
(Modified from Lee & Cherry, 1978)

The Rb-Sr, Sm-Nd systematics of the phlogopite-vein bearing peridotites in the Horoman peridotite complex, Hokkaido, Japan: origin of metasomatic fluids

M. Yoshikawa and N. Takahashi

The Horoman peridotite complex of southern Hokkaido is emplaced within the basal mylonite in the Hidaka metamorphic belt in a late Cretaceous accretionary prism. Cryptic and modal metasomatism have been reported in this complex. Rb-Sr and Sm-Nd systematics of the phlogopite-vein bearing peridotites in the Horoman complex indicate that modal metasomatism occurred 23-14 Ma in the shallow arc setting, after subsolidus breakdown of garnet and cryptic metasomatism event. The data further suggests that the modal metasomatism could have occurred during final uplifting of this peridotite complex to the surface coeval with upthrusting of the Hidaka metamorphic rocks, resulting from collision of two crust-mantle systems.

(To be submitted to Geology)

Three-dimensional P-wave Velocity Structure around Kuju Volcano, Kyushu, Japan

Mi. Yoshikawa, Y. Sudo, John M. Londono and H. Masuda

P-wave velocity structure around Kuju Volcano was obtained with 3-D seismic tomography. 6439 P arrival times were inverted in order to find a 3-D P wave velocity structure by using the method of Zhao et al. (1992). A good correlation with the surface geology was found for layer Z=0km (1km above sea level). Vp anomaly zones below Z=1km were found at some geothermal areas.

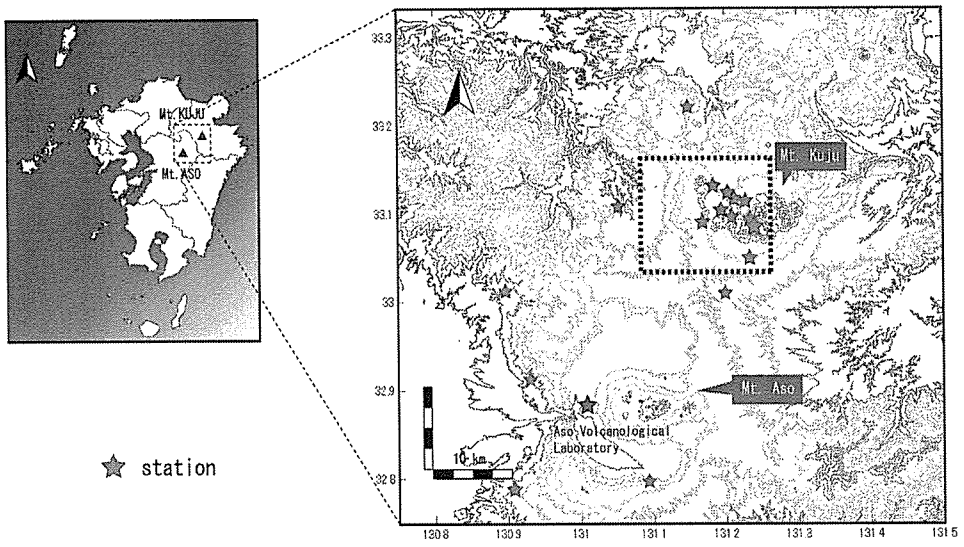


Fig. 1 Map of Kyushu island and distribution of seismic stations. The study area is closed with the broken line. Stars and triangles indicate seismic stations and tops of mountains, respectively. Many geothermal activity are observed around Kuju Volcano. A phreatic explosion occurred on October 1995 at Iwoyama in Kuju Volcano. Otake and Hatchobaru area is the distinguished geothermal area in Japan and geothermal power stations have been operating there.

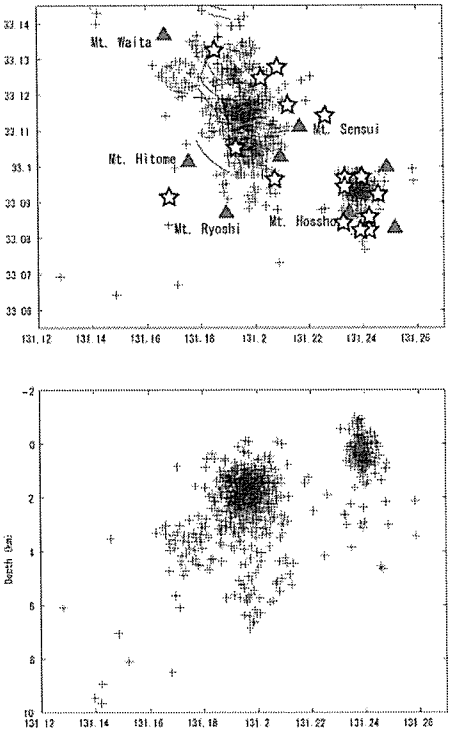


Fig. 2 Hypocenter distribution in this study area. 6439 P wave arrival times from 978 earthquakes observed during the period from October 1995 to October 2001 were applied to the tomographic inversion.

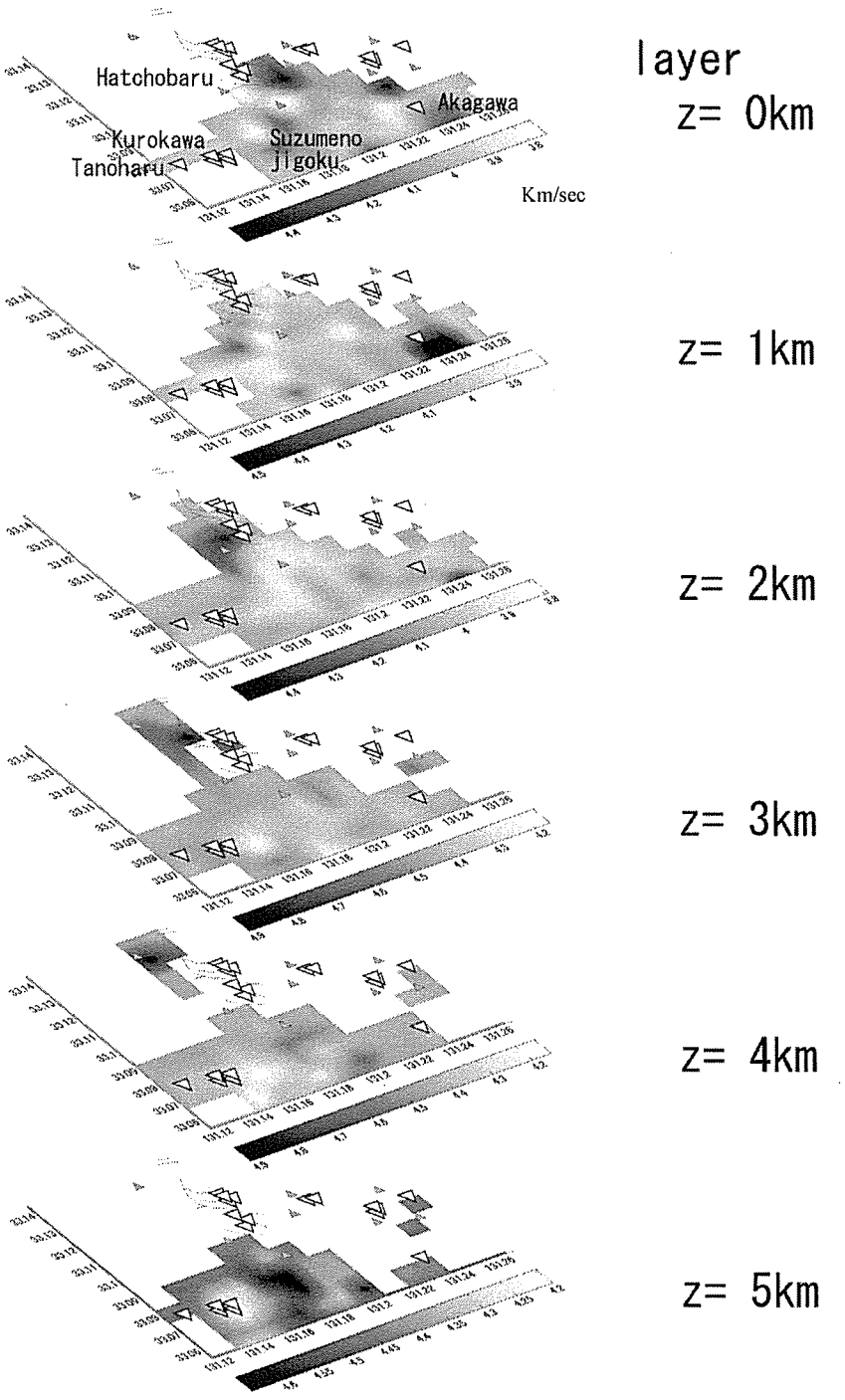
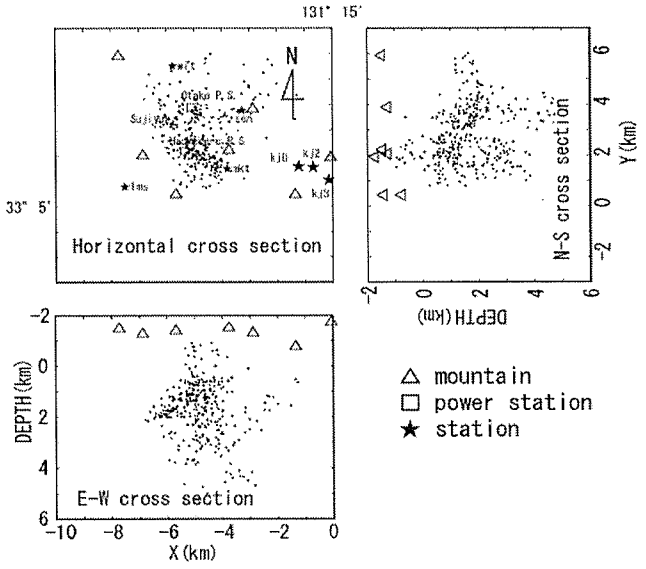


Fig. 3 Three-dimensional P-wave velocity model in the 6 layers (0, 1, 2, 3, 4 and 5 km depth from surface). Triangles and inverted triangles indicate tops of mountains and hot springs including fumaroles, respectively. A good correlation with the surface geology was found for layer Z=0km (1km above sea level). High P-wave velocity zones are located at regions observing lava flow from Kuju Volcano. Low P-wave velocity zone is located at the region observing volcanic fan deposit. Vp anomaly zones below Z=1km were found at some geothermal areas and hot springs around Kuju Volcano. High P-wave velocity zones are recognized at the Akagawa area at 1km depth (4.3km/sec) and the Otake geothermal area at 3km depth (4.9km/sec). Low P-wave velocity zone is located around the Kurokawa area (4.3km/sec) from 3km to 5km depth.

Vp/Vs Ratio and Seismic Activity at Geothermal Fields in the North-Western Area of Kuju Volcano, Kyushu, Japan

Mi. Yoshikawa, Y. Sudo, T. Tsutsui and S. Taguchi

The north-western area of Kuju Volcano is one of the most active geothermal fields in Japan, where the seismic activity including seismic swarms is very active. The Vp/Vs ratio study for earthquakes occurred at this area from November 1995 to May 1998 was carried out. At the shallow part (above 2km below sea level), Vp/Vs ratios are wide ranging 1.65 to 1.85. On the contrary, almost all of Vp/Vs ratios are limited at the values less than 1.73 at the deeper part (deeper than 2km below sea level). The Vp/Vs ratio changes with time and increases before the seismic swarm. These characteristics are inferred to be affected by the presence of water and fractures in the geothermal field.



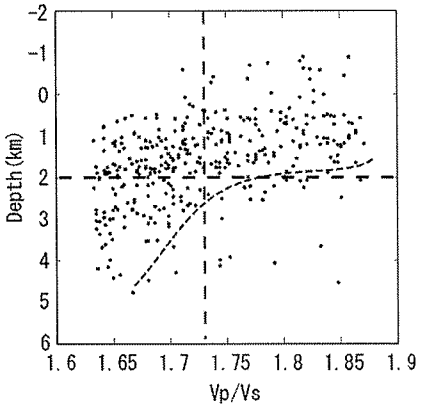


Fig.2 The relation between focal depths and Vp/Vs ratios.

Fig.1 Hypocentral distribution (212 events) in the study area during the period from November 1995 to March 1998. Errors of Vp/Vs ratios in these events are less than 0.100.

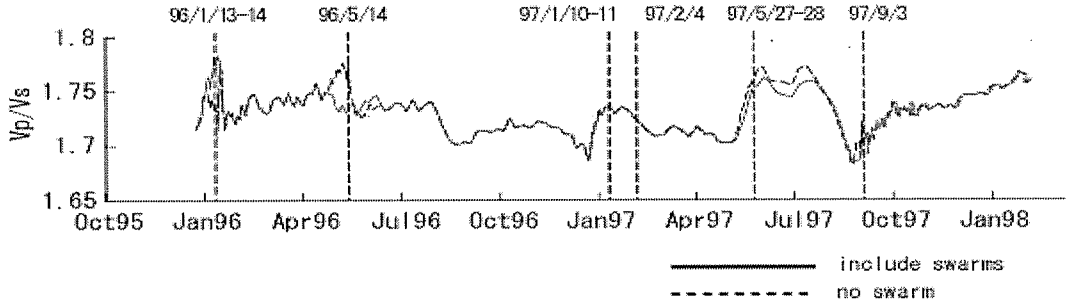


Fig.3 Temporal change of Vp/Vs ratio. The line shows the average of Vp/Vs ratio for a running time window of 15 events stepped by 1 event. Solid line; no swarm. Broken line; include swarms. Each date in the figure shows the time of each swarm. Circles in the figure indicate that Vp/Vs ratios in the seismic swarm could be obtained. Crosses indicate that Vp/Vs ratios in the seismic swarm could not be obtained.

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共同研究 Collaboration

国内

橋本武志：大山ＭＴ調査・鳥取県西部地域ＭＴ調査(京大理・鳥取大工・京大防災研・北大理・高知大理・神戸大理・東大震研・東工大理)

川本竜彦：岡山大学固体地球研究センター嘱託研究員

大沢信二：山地斜面の地下水に関する研究（京都大学防災研究所研究担当）

大沢信二：別府海地獄の地球化学的・色彩学的研究（東邦大学理学部化学科）

大沢信二：別府地熱地帯に産する酸性泉中の希土類元素の存在度　参加機関：東邦大学理学部化学科

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鈴木勝彦：「大山火山岩の Os：reheating process」(JAMSTEC，田村)

鈴木勝彦：「Hot spot 海洋島玄武岩の Re-Os，Pt-Os systematics：地球中心核の contribution を探る」(JAMSTEC，本多，篠塚，巽，産総研，下田)

鈴木勝彦：「Polynesia Tubuai OIB とマントル端成分」(JAMSTEC，本多，巽)

鈴木勝彦：「EXAFS による天然岩石中の白金族元素の存在状態」(広大，高橋・清水)

竹村恵二：「洪積粘土の構造特性と大阪湾岸の埋立地における長期沈下メカニズム解明に関する研究」（京都大学防災研究所共同研究；研究代表：三村衛）

竹村恵二：「京都盆地の地盤に関する研究」関西地盤情報活用協議会

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田中良和・橋本武志：雲仙科学掘削計画・地球電磁気観測（東大震研・京大防災研・国土地理院・九大理）

国際

大倉敬宏：フィリピン・マコロード回廊における GPS 観測（フィリピン火山地震研究所）

大倉敬宏：インドネシア北スラベシにおけるジオダイナミクス（名古屋大学、高知大学、バンドン工科大学、フィリピン火山地震研究所）

鈴木勝彦：「Os 同位体を用いた中国大陸下 lithospheric mantle の年代と形成過程」(中国，LI Xiaolin，都立大，海老原)

鈴木勝彦：「Os 同位体による中国の高圧 garnet peridotite の同位体と大陸下マントル」 (中国, XU Jifeng：日本学術振興会２国間交流事業)

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鈴木勝彦：「中国かんらん岩 xenolith の Os 同位体比を用いた lithospheric mantle の進化」(中国, XU Jifeng：日本学術振興会２国間交流事業)

鈴木勝彦：「インド black shale の形成過程」 (インド, Roy)

鈴木勝彦：「Polynesia Rarotonga OIB とマントル端成分」 (香港大, Gary Thompson, JAMSTEC, 本多, 巽),

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海洋科学技術センター固体地球統合フロンティア研究システムとの共同研究

海洋科学技術センター(JAMSTEC)固体地球統合フロンティア研究システム(IFREE)と地球熱学研究施設（別府）(BGRL)は、「同位体分析に基づく島弧マグマの起源並びに進化過程の解明」というテーマで共同研究を行うことに合意し、平成 13 年 4 月 1 日付けで覚書を交わした上、共同研究を開始した。これの実施のため、JAMSTEC から BGRL に篠塚・本多・常の 3 名の研究者が派遣（BGRL 常駐）され、BGRL からは柴田・鈴木・芳川の 3 名の研究者が JAMSTEC に短期派遣された。また、JAMSTEC は BGRL に表面電離型質量分析計・クリーンドラフト・クリーンベンチ等の設置および微量元素・同位体分析に関わる消耗品の提供を行い、BGRL は電子マイクロプローブを JAMSTEC に貸与した。これにより、BGRL で微量元素・同位体分析を中心とした地球化学的研究を、JAMSTEC で岩石学・地球年代学的研究をそれぞれ主に分担する共同研究体制を構築した。本年度は島弧火山岩や海洋島玄武岩などの研究を実施し、その成果の一部は既に科学雑誌に投稿されている（本年報研究報告参照)。この共同研究は次年度も継続される予定である.

Collaboration between Institute for Frontier Research on Earth Evolution, Japan Marine Science and Technology Center and Beppu Geothermal Research Laboratory

Institute for Frontier Research on Earth Evolution (IFREE), Japan Marine Science and Technology Center (JAMSTEC) and Beppu Geothermal Research Laboratory (BGRL) made a note on the collaboration, which directed to "Investigation of genesis and evolution processes of island arc magma inferred from isotope analyses", dated on Apr 1, 2001. To be realizing the collaboration, three scientists of Shinotsuka, Honda and Chang dispatched from JAMSTE to BGRL (always stay in BGRL), and also three scientists of Shibata, Suzuki and Yoshikawa dispatched from BGRL to JAMSTE (in a short time). Furthermore, JAMSTEC installed a thermal ionization mass spectrometer, clean drafts, clean benches etc, in BGRL and offered expendables to BGRL for trace element and isotope analyses, and BGRL lent an electron micro probe analyzer to JAMSTEC. From these, scientific collaborating system was established that geochemical studies of trace and isotope analyses, and petrological and geochlonogical studies are carried out at BGRL and at JAMSTTEC, respectively. In 2001 FY, island arc volcanics and ocean island basalts have been studied and some part of the results were already submitted to scientific journals (see scientific report in this volume). The collaboration system will be continued in next year.

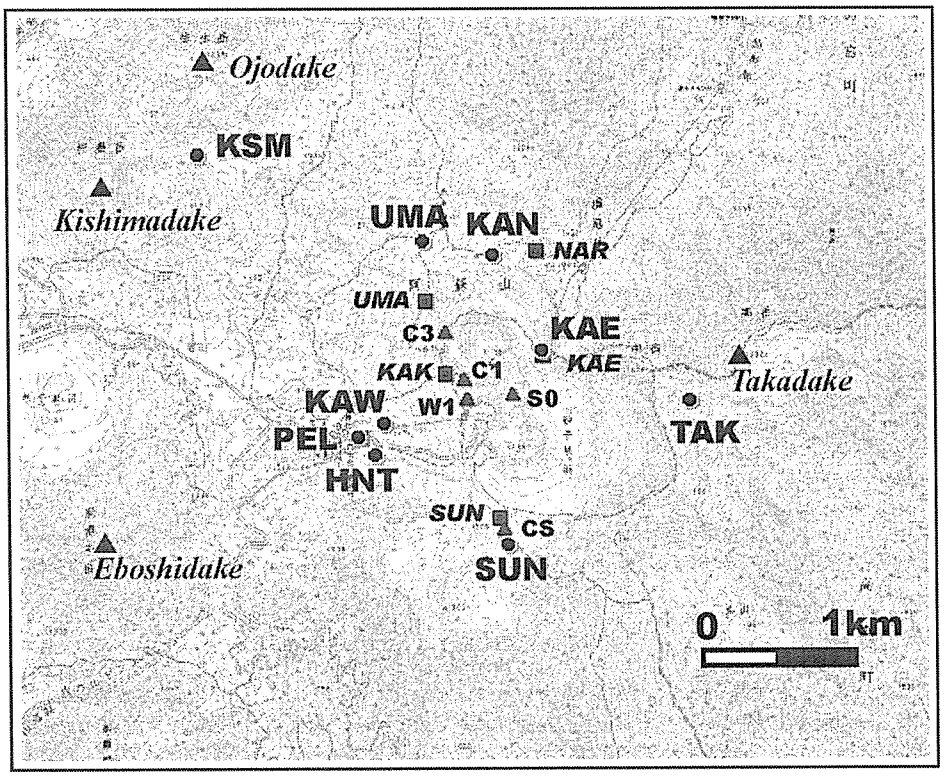
Geophysical Monitoring Under Operation at AVL

Aso Volcanological Laboratory

Permanent Stations

Nakadake monitoring network

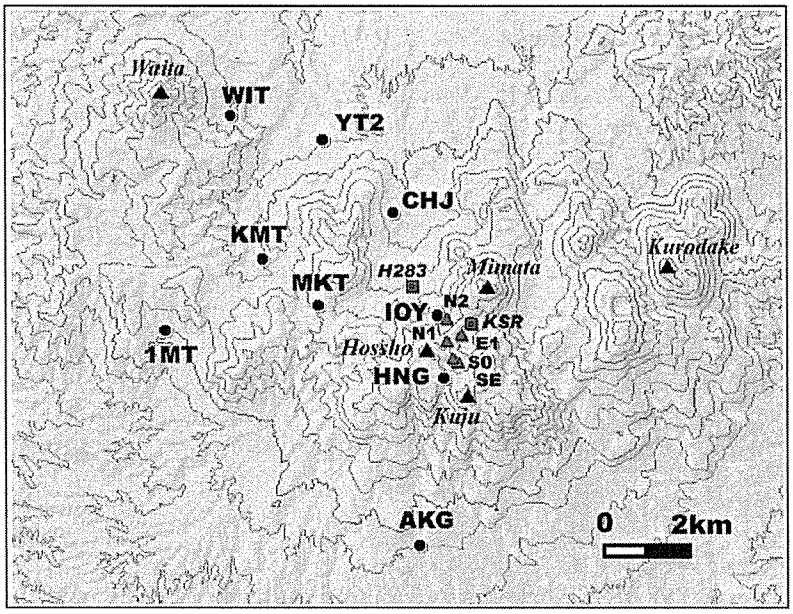
Seismic Stations : HNT, PEL, KSM, SUN, KAE, KAE, KAN, UMA, TAK (microwave telemetry)
Tiltmeters : HNT (water tilt 3-comp.), SUN, KAE, NAR, UMA, KAK (on-site logging)
Extensometers : HNT (invar 3-comp.)
Microphone : HND (microwave telemetry)
Geomagnetic Stations : C1, C3, S0, W1, CS, NGD, FF1 (proton; on-site logging)
C223 (fluxgate 3-comp.; on-site), newC223 (fluxgate 3-comp.; online)
FF2 (proton; online)
Ground Temperature : KAK (boreholes of 70 and 150 m deep; microwave telemetry)



Seismic, geodetic and geomagnetic stations in the central part of Aso.

Kuju monitoring network

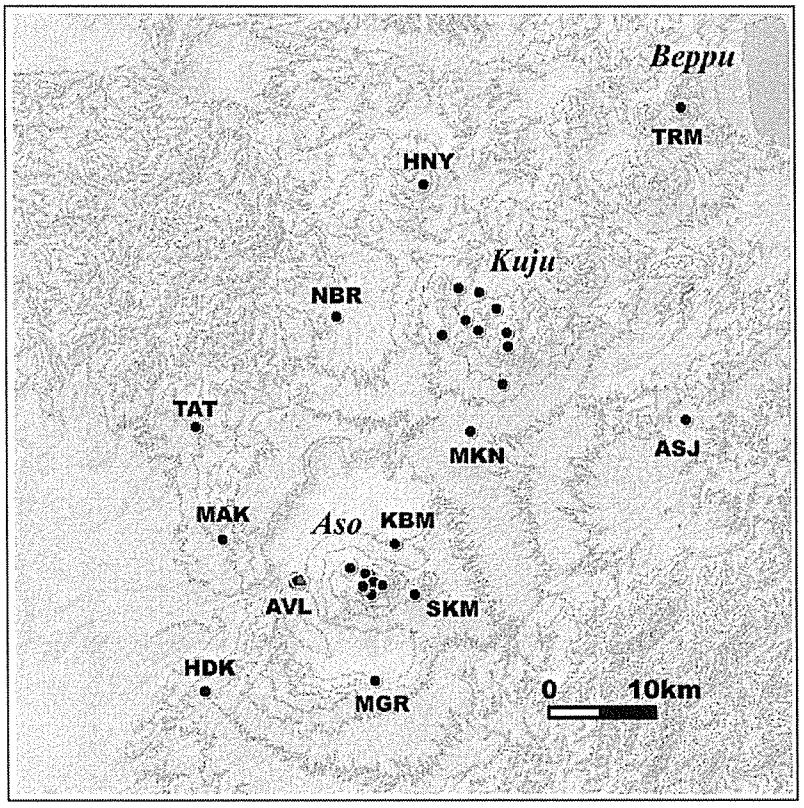
Seismic Stations : HNG (radio-telemetry), AKG, CJB, IOY (on-site logging)
Tiltmeters : H283, KSR (on-site logging)
Geomagnetic Stations : N2, E1, S0, SE (proton; on-site logging)



Seismic, geodetic and geomagnetic stations in Kuju area.

Central Kyushu regional network

Seismic Stations : AVL(6), MAK, NBR, MKN, HDK, TAT, MGR (online telemetry)
ASJ, HNY, SKM, KBM, TRM (dial-up)



Seismic network in the central Kyushu.

Periodical Surveillance Programs

Gravimetry
GPS
Levelling
EDM
Geomagntic survey

Volcanic earthquakes near Mt. Naka-dake, Aso Volcano in 2001

H. Ono

The first crater of Mt. Naka-dake, Aso Volcano has been covered with hot water pool since 1993. The incandscent state at the south part of the first crater has continued since October, 2000.

Volcanic earthquake activity was calm near the active crater of Mt. Naka-dake in 2001. The daily number histogram of volcanic earthquakes were shown in Fig. 1.

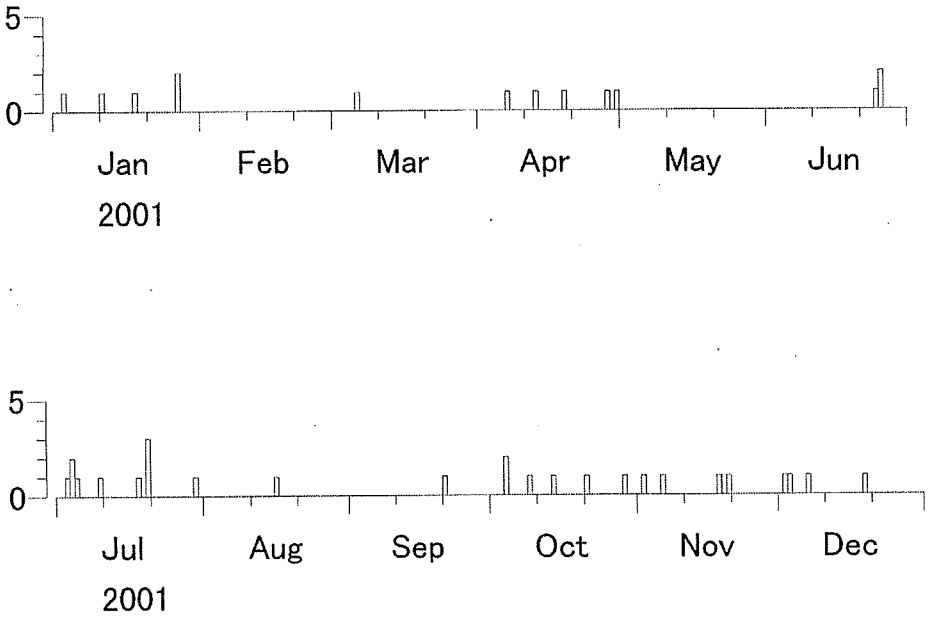


Figure 1. Daily number histogram of volcanic earthquakes in 2001.

Ground deformation observation in 2001

H. Ono

The tunnel for ground deformation observation locates in 30m underground at about 1km south-west from the first crater of Mt. Naka-dake and consists of horizontal tunnels forming equilateral right-angled triangle. Watertube tiltmeters of 25m span (WT1 and WT2) and extensometers of 20m span (E1 and E2) and 25m span (E3) have been installed.

The ground deformation observed by tiltmeters and extensometers in 2001 is shown in Fig. 2 with precipitation by Aso-san Weather Station, JMA.

Extensometers recorded annual variation with strain amplitude of 10^{-6} order.

The northwest uplift of 5 μ radian was observed by tiltmeters in 2001. This tilt motion has continued since August, 2000. It is doubtful whether this uplift will progress to volcanic eruption, because the uplift direction is perpendicular to the active crater.

Precipitation in June and July, 2001 had influence on ground deformation.

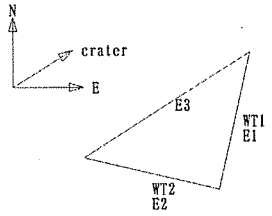


Figure 1. Tunnel and setting of watertube tiltmeters (WT1, WT2) and extesometers (E1, E2, E3).

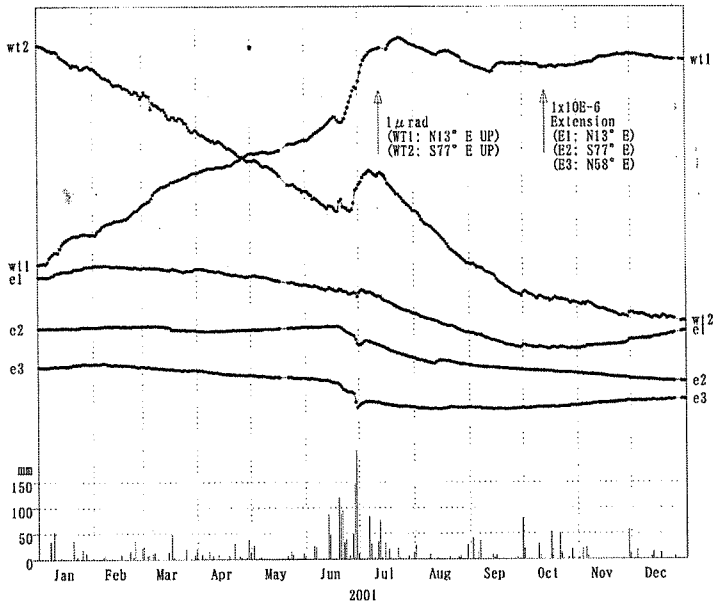


Figure 2. Ground deformation records in 2001. Lower is daily precipitation by Aso-san Weather Station, JMA.

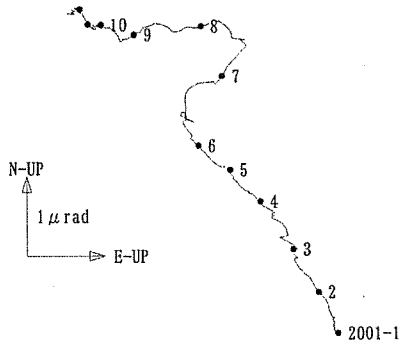


Figure 3. Upward vector from watertube tiltmeter observation. Attached numbers show months (1st day).

Seismic Activity around Aso Caldera and Kuju Volcano during the period from April in 2001 to March in 2002

Y. Sudo and Mi.Yoshikawa

A telemetrically seismic network around Aso Caldera and Kuju Volcano is composed of 17 stations. Several earthquakes have occurred at the northwestern side area of Kuju Volcano. On 7th and 8th in May 2001, at the northwestern region of Kuju Volcano the big swarm occurred, some events were felt. The largest events occurred at 17:16 and at 23:14 on 7 May, their magnitude were both 3.2. The mechanism of these events indicate a combination of both normal and right lateral strike-slip type faults. The tension axis maintains a horizontal north-south orientation.

In Aso Caldera, there was no remarkable seismic event during this period.

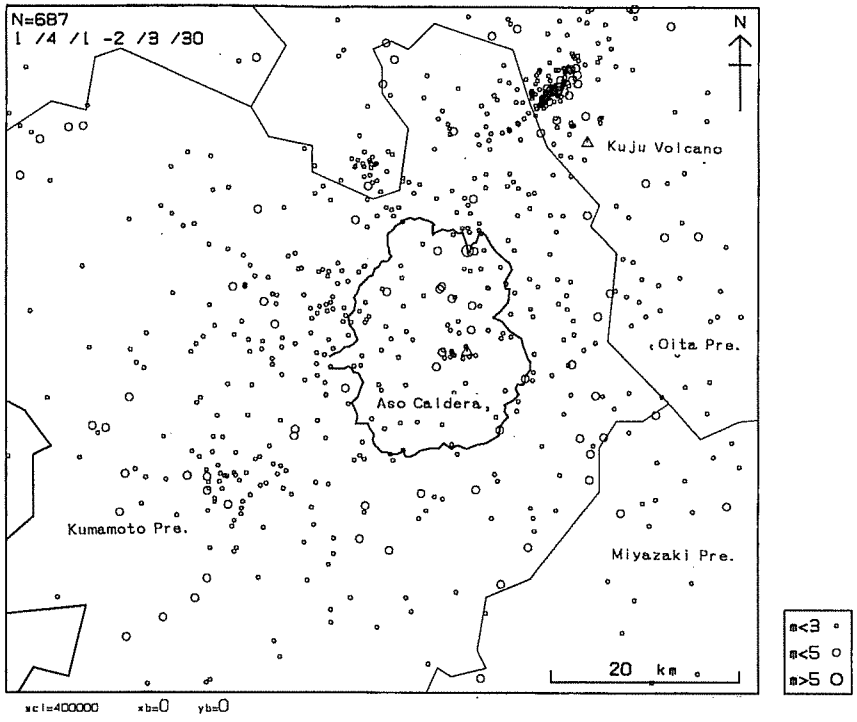


Fig. 1. Epicenteral distribution of events occurred at the region of Aso Caldera and Kuju Volcano during the period from April in 2001 to March in 2002.

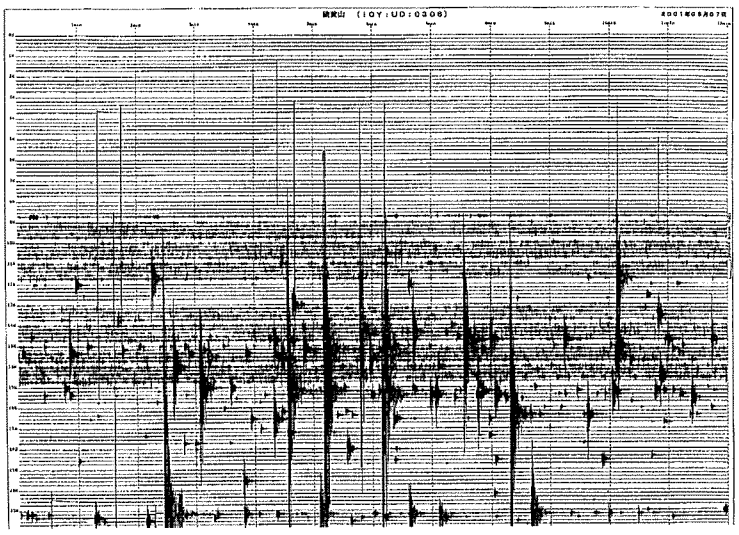


Fig. 2. Seismogram of Kuju swarm.

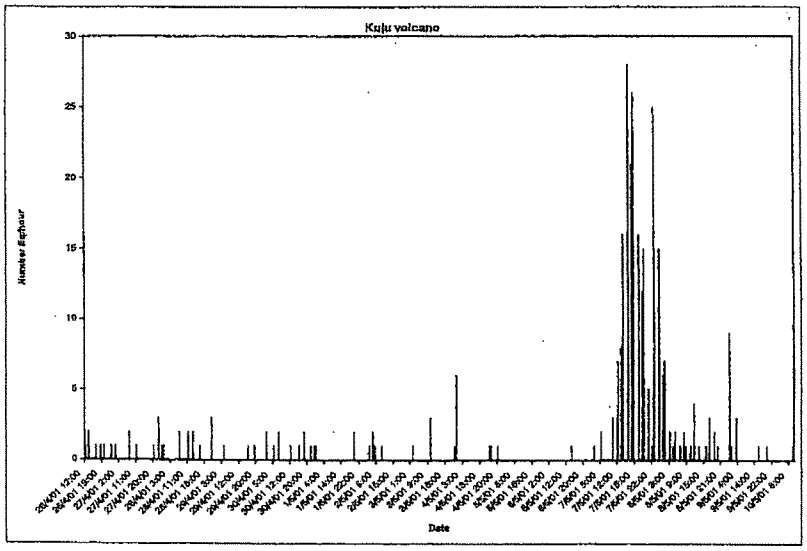


Fig. 3. Histogram of Kuju swarm.

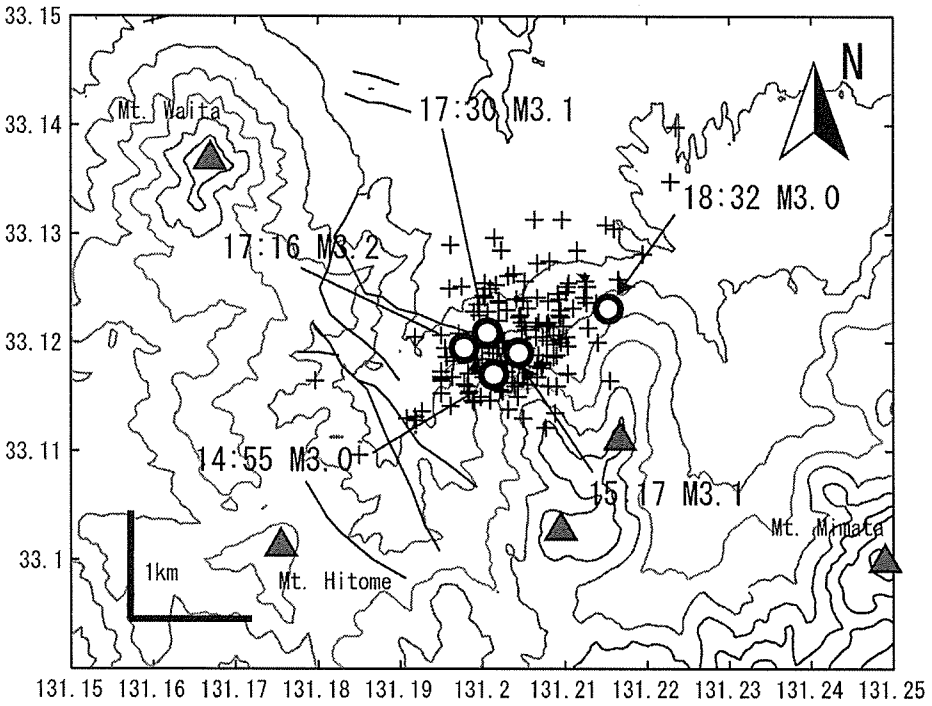


Fig. 4. Epicenter of Kuju swarm.

Analyses of Sr and Nd isotope ratios of GSJ and USGS rock standards

T. Shibata, M. Yoshikawa and Y. Tatsumi

Analytical methods for Sr and Nd isotopic compositions were established at BGRL , and few analytical results for rock standards were reported in Yoshikawa et al. (2001). Recently, rock standard materials, which are well distributed around the world, are getting to be short supply so that new rock standards have been made by Geological Survey of Japan (GSJ) and U.S. Geological Survey (USGS). However, published analytical results for Sr and Nd isotope ratios are not enough to make comparisons with inter laboratory. Therefore, we analyzed newly distributed rock standards and the results were listed in Table 1 with those of well-distributed standards.

(to be submitted to Geochemical Journal)

Table 1. Sr and Nd isotope ratios of GSJ and USGS rock standards.

	$^{87}Sr/^{86}Sr$	$^{143}Nd/^{144}Nd$	Reference		$^{87}Sr/^{86}Sr$	$^{143}Nd/^{144}Nd$	Reference
JA-1	0.703250 ± 50	0.513100 ± 20	1			0.512768 ± 09	8
	0.703586 ± 11		2		0.704115 ± 17	0.512780 ± 11	11
	0.703636 ± 10		3		0.704107 ± 08	0.512782 ± 06	12
	0.703670 ± 50		4		0.704097	0.512768	10
	0.703507 ± 16	0.513065 ± 10	5		0.704100		16
	0.703630 ± 10	0.513088 ± 08	6		0.704093		17
	0.703637 ± 12		7		0.704136 ± 05	0.512750 ± 13	This study
	0.703572 ± 08		8				
		0.513086 ± 05	9	JB-2	0.703450 ± 30	0.513110 ± 20	1
	0.703533	0.513066	10		0.703754 ± 14		2
	0.703557 ± 18	0.513078 ± 08	11		0.703753 ± 10		3
	0.703543 ± 06	0.513092 ± 12	12		0.703760		18
	0.703566 ± 07	0.513102 ± 18	This study		0.703630 ± 10	0.513078 ± 08	6
					0.703637 ± 12		7
JA-2	0.706370		4		0.703691 ± 08		8
	0.706334 ± 08	0.512530 ± 11	12			0.513090 ± 30	19
	0.706338 ± 06	0.512558 ± 13	This study			0.513085 ± 06	16
						0.513055 ± 08	9
JA-3	0.704270		4			0.513078	20
	0.704160 ± 10	0.512859 ± 08	12		0.703709 ± 29	0.513085 ± 08	11
	0.704183 ± 08	0.512859 ± 14	This study		0.703668 ± 11	0.513090 ± 08	12
					0.703703 ± 11	0.513097 ± 11	This study
JB-1	0.704170		2				
	0.704094		13	JB-3	0.703477 ± 14		2
	0.704126		14		0.703493 ± 10		3
		0.512786	15		0.703428 ± 10	0.513054 ± 08	6
	0.704144		This study		0.703410 ± 10		7
					0.703439 ± 05		8
JB-1a	0.704348 ± 15		3			0.512990 ± 20	19
	0.704200 ± 40		4			0.513046 ± 08	9
	0.704083 ± 16	0.512784 ± 11	5			0.513035 ± 09	8
	0.704080 ± 10	0.512780 ± 06	6			0.513042	20
	0.704133 ± 07		8		0.703432 ± 16	0.513056 ± 06	11
	0.704106 ± 12	0.512785 ± 34	14		0.703410 ± 05	0.513037 ± 06	12
		0.512770 ± 05	16		0.703446 ± 06	0.513048 ± 09	This study
		0.512780 ± 09	9				

Table 1 (continued)

	$^{87}Sr/^{86}Sr$	$^{143}Nd/^{144}Nd$	Reference		$^{87}Sr/^{86}Sr$	$^{143}Nd/^{144}Nd$	Reference
JG-1	0.710830		2		0.705241± 28	0.512647± 10	11
	0.710790	0.511620	21		0.705205± 15	0.512648± 20	12
	0.710995		14		0.705284± 10	0.512664± 07	This study
		0.512340	19				
	0.710981± 22	0.512370	15	**JP-1**	0.708582		3
	0.711070± 11	0.512372± 07	This study		0.706637		16
					0.708417± 14	0.512174± 52	This study
JG-1a	0.711036± 10		3				
	0.710980± 30		4	**JR-1**	0.704258± 14		2
	0.710973± 14	0.512377± 19	5		0.704206± 10		3
	0.710980± 10		6		0.704180± 30		4
	0.710987± 07		8		0.704110± 10		6
	0.710924± 21		14		0.704156± 13		7
		0.512378± 18	9			0.512850± 20	19
	0.710988	0.512375	10			0.512906± 06	9
		0.512345± 09	8		0.704176	0.512895	10
		0.512380	20		0.704157± 11	0.512898± 15	11
	0.710981± 22	0.532365± 10	11		0.704127± 09	0.512908± 07	12
	0.710970± 13	0.512383± 09	12		0.704169± 11	0.512901± 08	This study
	0.711093± 11	0.512372± 07	This study				
				JR-2	0.705570		2
JG-2	0.758560		4		0.705532		3
		0.512212± 15	12			0.512913± 11	12
	0.759197± 14	0.512225± 08	This study		0.705482± 11	0.512919± 08	This study
JG-3	0.705520		4				
	0.705360± 19	0.512617± 17	12	**JLs-1**	0.707885± 12		This study
	0.705426± 11	0.512618± 08	This study	**JDo-1**	0.707565± 11	0.512233± 16	This study
				JSI-1	0.711934± 12	0.512517± 10	This study
JGb-1	0.705247± 14		2	**JSd-1**	0.705760± 12	0.512558± 22	This study
	0.705324± 10		3	**AGV-1**	0.703992± 06	0.512777± 20	This study
	0.705190± 10		6	**AGV-2**	0.704040± 11	0.512797± 35	This study
	0.705185± 18		7	**BCR-2**	0.705165± 17	0.512620± 09	This study
		0.512624± 08	9	**BHVO-1**	0.703505± 06	0.512972± 15	This study
	0.705239	0.512641	10	**GSP-2**	0.765350± 33	0.511337± 08	This study
		0.512635	20				

1; Nohda and Wasseburg(1981), 2; Kurasawa (1984)*, 3; Shirahase and Nakajima(1984), 4; Zhang and Zicha(1987)*, 5; Kagami et al.(1989), 6; Okano et al.(1989), 7; Notsu and Hirao(1990), 8; Iizumi et al.(1994), 9; Arakawa(1992), 10; Na et al. (1995), 11; Orihashi et al.(1998), 12 Miyazaki & Shuto (1998); 13; Herve et al. (1993), 14; Yamamoto and Maruyama(1996), 15; Kagami et al. (1987), 16; Abe and Yamamoto (1999), 16; Takahashi and Masuda (1990), 17; Yuhara et al. (1999), 18; Zichao (1987), 19; Tanaka et al.(1987), 20; Pin and Zalduegui (1997), 21; Nohda (1982).

Analytical Procedure of Osmium and Rhenium

K. Suzuki

(After Suzuki and Tatsumi, 2001, Geochem. J., in press)

The analytical procedure used here is based on the Carius tube digestion (Shirey and Walker, 1995) combined with carbon tetroxide extraction (Cohen and Waters, 1996; Pearson and Woodland, 2000) with some modifications. The Carius tube method (Shirey and Walker, 1995) is an effective decomposition technique for achieving complete isotopic equilibration of sample-derived Os with the enriched spike in a wide range of geological materials, although the possibility of accidental sample loss by explosion exists. 2.5 to 5 g of the reference rocks were weighed and added with Re (typically 0.1 – 0.5 ml) and ^{190}Os spike solutions (0.1 – 0.5 ml) and heated in inverse aqua regia in a sealed Carius tube at 220 °C for at least 24 hours. After cooling, the tube was opened carefully.

Carbon tetroxide extraction was used for Os separation. We followed the methods developed by Cohen and Waters (1996) and Pearson and Woodland (2000). The solution and sample residue is transferred to 30ml PFA vessel and added with 4 ml of chilled carbon tetrachloride. This mixture is allowed to warm and shaken for 2 min. The organic fraction is then filtered by solvent extraction filter paper. The filtrate organic phase containing Os extracted. Organic extraction of the aqua regia fraction is performed twice more to ensure consistent Os recovery, which was added with 9N HBr. Then, the mixture was tightly capped in a Teflon vessel, allowed to warm to room temperature and then shaken for 2 min and kept under a heat lamp for 1 h. On cooling, the Os-bearing HBr was filtered by solvent extraction filter paper from the organic phase and dried. The residue was further purified by microdistillation (Roy-Barman, 1993)

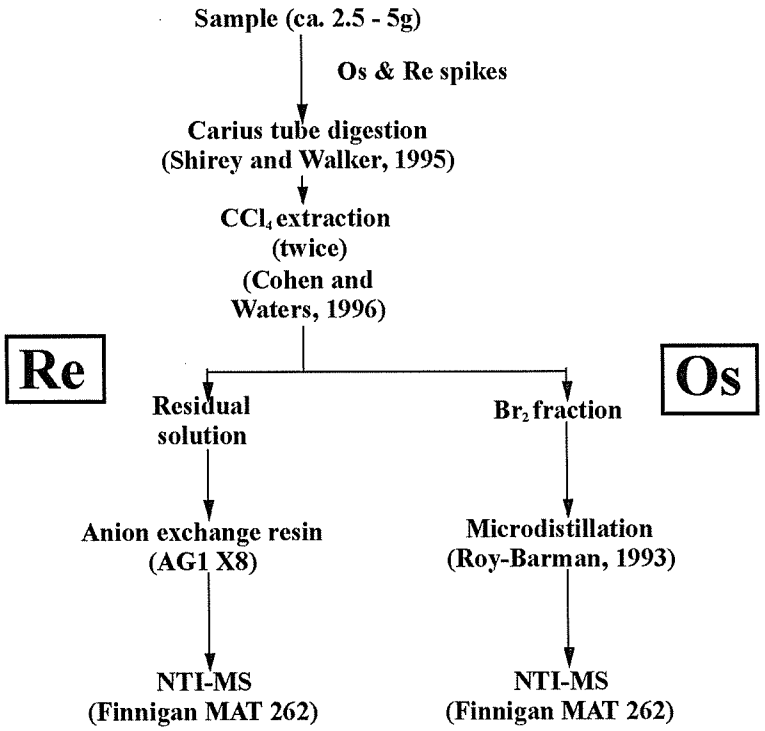


Fig. 1. Analytical procedure.

Rhenium was separated from the aqueous phase left behind the Br_2-extraction of Os, using Muromac AG 1X8 anion exchange resin. Both Re and Os were corrected for blanks. Total procedural blanks for Os and Re are 6.318 pg with $^{187}Os/^{188}Os$ =0.1744 +/- 0.0070 and 20 pg, respectively.

All measurements presented here were performed on a Finnigan MAT^R 262 mass spectrometer in a negative ion detection mode (Creaser et al., 1991; Volkening et al., 1991) equipped with a gas leak valve and an ion counting multiplier. A high purity Pt filament (99.999 %, 0.5 mm x 0.025 mm, H. Cross Co. or 99.99 %, 1 mm x 0.025 mm, Tanaka Precious Metal Co.) was baked in air to a bright red temperature for more than three minutes. Osmium loaded on the Pt filament was covered with 10 μg

Ba and 2 μg Na. Custom-made 10,000 ppm $Ba(NO_3)_2$ solution (SPEX) was used. Both Re and Os blanks in the solution used were less than 0.01 pg. The filament was then heated in air until the loaded material started to melt and then quickly cooled, which reduces the organic interferences at masses 233-235 in Os isotopic measurements (Birck et al., 1997). This step was omitted in the Re isotopic measurements. Osmium and Re isotopic compositions were measured in the static multiple Faraday collector mode or in the pulse counting electron multiplier mode. Instrumental mass fractionation of Os was corrected by normalizing the $^{192}Os/^{188}Os$ ratio to 3.08271 (Nier, 1937). The subtraction of oxygen contributions for Os and Re was conducted using the ratios of $^{17}O/^{16}O$ = 0.00037 and $^{18}O/^{16}O$ = 0.002047 (Nier, 1950).

A high blank of Re in mass spectrometer would cause serious troubles for isotopic measurements of low-level Re (e.g., Shen et al., 1996; Birck et al., 1997). We found the major source of high Re blank in mass spectrometry is the sample magazine, which supports filament holders. When the magazine was employed which had been used for Pb and Nd measurements on Re filaments, at first high Re loading blank of 10 – 15 pg was observed. Rhenium emitted from Re filaments is possibly attached on the surface of the sample magazine and may be ionized at high temperature caused by following filament heating. The Re blank was reduced to 0.3 pg after 12 months operation of the TIMS without Re filaments.

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装置・設備　Instruments and Facilities

装置　Instruments

【別府】
ICP 発光分光分析装置
波長分散型電子プローブマイクロアナライザー
（海洋科学技術センターに貸し出し中）
エネルギー分散型電子プローブマイクロアナライザ
波長分散型蛍光 X 線分析装置
エネルギー分散型蛍光 X 線分析装置
粉末 X 線回折装置
液体シンチレーションシステム
イオンクロマトグラフ
ガスクロマトグラフ
自動滴定装置
ピストンシリンダー型高圧発生装置
ICP-MS 用レーザーアブレーション装置
四重極型 ICP－MS 装置
表面電離型質量分析装置
外熱式ダイアモンドアンビル
フーリエ変換型近赤外分光光度計
赤外顕微鏡
加熱ステージ

【阿蘇】
阿蘇，九重火山連続地震観測システム
地殻変動観測坑道
孔中温度観測システム
ビデオ映像監視システム
プロトン磁力計
フラックスゲート磁力計
地磁気絶対測定システム
傾斜計
可搬型地震計（広帯域，短周期）
人工震源車
重力計
超伝導重力計
地磁気地電流測定装置（広帯域型 ULF, ELF, VLF 型）
光波測距儀
水準測量システム（自動読み）

【Beppu】
ICP emission Spectrometer
Wavelength dispersive electron microprobe (lent to JAMSTEC)
Energy dispersive electron microprobe analyzer
Wavelength dispersion type X-ray Fluorescence analyzer
Energy dispersionty type X-ray Fluorescence analyzer
Powder X-ray diffractometer
Liquids scintillation system
Ion chromatography
Gas chromatography
Automatic titration system
Piston cylinder type high pressure apparatus
Laser ablation system
Inductively coupled plasma mass spectrometer (ICP-MS)
Thermal ionization mass spectrometer (TIMS)
Externally heated diamond anvil cell
FT-NIR spectrometer
IR microscope
Heatings stage

【Aso】
Continuous seismic monitoring system for Aso and Kuju Volcanoes
Observation tunnel for ground deformation
Borehole temperature monitoring system for Aso
Video monitoring system of Aso and Kuju Volcanoes
Proton and fluxgate magnetometers
Geomagnetic absolute measurement system
Tiltmeters
Portable seismometers (broadband short period)
Car-mounted seismicsource
Gravimeters
Super-Conducting Gravimeter
Magneto-Telluric measurement system (broad-band type, ULF, ELF, VLF-band)
Electronic distance measurement system
Leveling survey system (automatic reading)

設備　Facilities

岩石粉砕・鉱物分離室

パックミル・ディスクミルによる岩石粉砕やアイソダイナミックセパレータによる鉱物分離を行う．

器具洗浄室

実験に用いる器具の洗浄を行う．ドラフト 2 台・イオン交換筒・Milli-Q が設置されている．

クリーンルーム

HEPA フィルターを設置し極力金属使用を控えた設計で，クラス 100 のクリーン度を達成している．Sr・Nd・Pb 同位体比分析のための化学処理（試料の分解・イオン交換クロマトグラフィーによる目的元素の抽出）を行っている．

地下観測坑道（阿蘇火山地殻変動観測坑道）

阿蘇中岳第一火口から南西 1km の，地下 30m に設けられた，直角三角形の水平坑道で，1987 年度に竣工した．現在は，水管傾斜計（25m），伸縮計（20，25m），短周期地震計，長周期地震計，広帯域、地震計、強震計、超伝導重力計が設置されている．

新規導入

● 火山研究センター構内地震観測システム

火山研究センター構内では，従来からトリパタイトによる地震観測を行ってきたが，平成 13 年度に，ノイズ低減の為，約 200m のボーリング孔を 4 本掘削し，孔底に地震計を導入した．これにより，S/N 比は大幅に改善され，従来識別できなかった中岳の長周期微動が検出されるようになった．また，ボーリングコアを採取したことにより，研究センターの丘，高野尾羽根（たかのおばね）火山について地質学的に新たな知見が得られつつある．これは，阿蘇中央火口丘の噴火史を研究する上でも貴重な資料である．

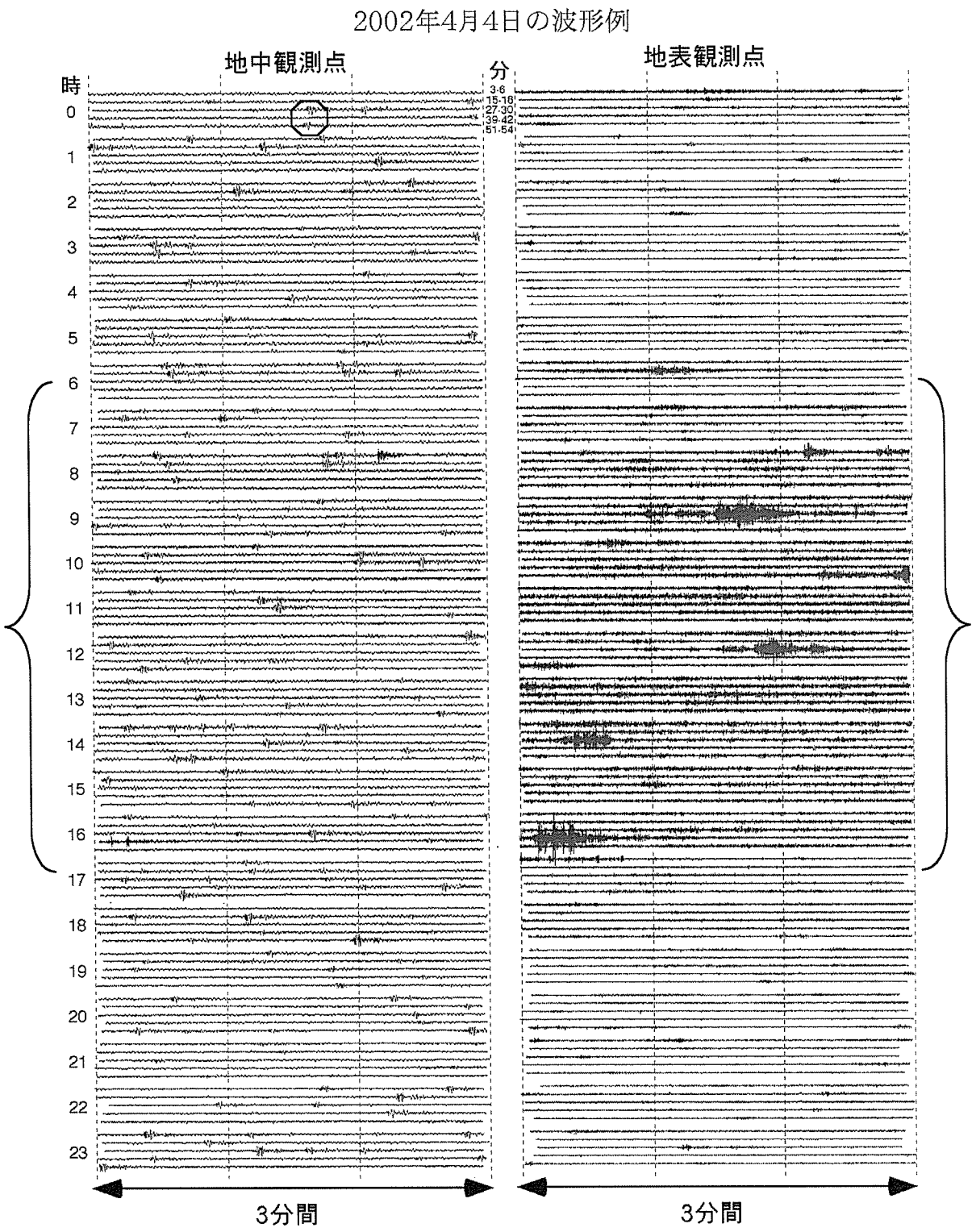

Fig. 1 : 2002 年 4 月 4 日の地震記象比較．左は孔中地震計，右は地表地震計の記録．毎時 3 分、15 分、27 分、39 分、51 分からの 3 分間の波形が示されている。孔中観測では，｜｜で示されているように昼間の人工雑音の影響がないことがわかる．また，これまでの地表観測では見えなかった中岳の孤立型長周期微動（○印内）も，孔中地震計では識別できるようになった．

● 火山研究センター構内地磁気観測システム

火山研究センターでは，従来よりフラックスゲート磁力計による地磁気 3 成分とプロトン磁力計による地磁気全磁力の観測を行ってきたが，平成 13 年度に，ノイズ低減の為，観測系を構内西側に移設した．約 30 m 長の横穴にフラックスゲート磁力計（島津製作所製）を設置し，地磁気 3 成分観測を行うと共に，地表ではオーバーハウザー磁力計（GEM 社製）による全磁力観測を開始した．分解能は 0.01 nT, サンプリングは毎秒である．また，これに伴い，既設の地磁気絶対値観測室も移設した．

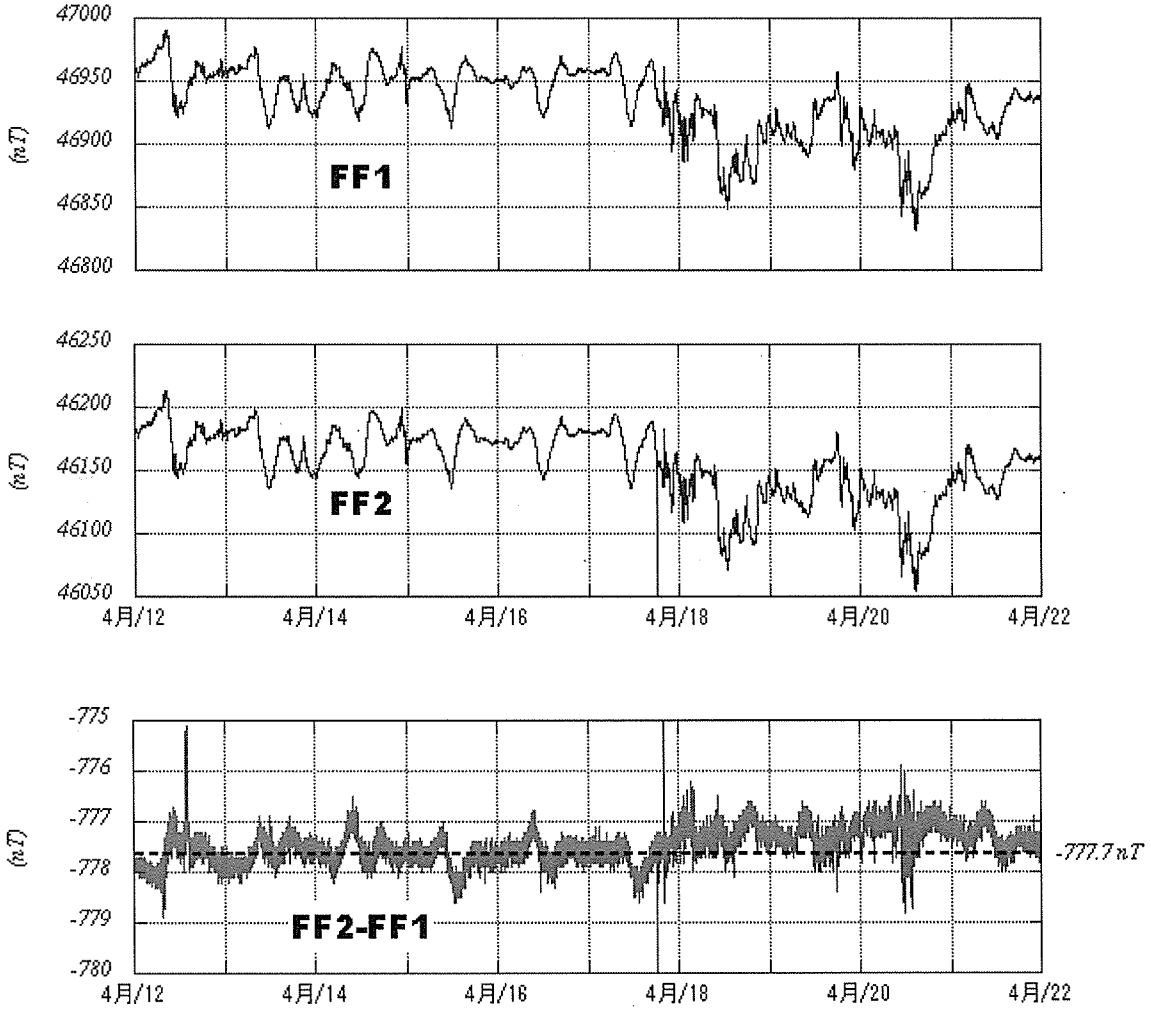

Fig. 2 ：旧観測点(FF1)と新観測点(FF2)における全磁力変化の比較（2002 年 4 月 12 日 00 時～4 月 22 日 00 時 JST）．最下図は両者の差．新旧観測点における全磁力の差は，暫定値として 777.7 nT と求まった．

● CO2 ガスフラックス計（WEST SYSTEMS 社製　LI-800）

チャンバー方式により土壌二酸化炭素フラックスを計測できる装置．携帯型であるため，フィールドでの多点測定に適している．

研　究　費　Funding

<u>科学研究費補助金</u>

基盤研究　ＣＯＥ形成　竹村恵二（分担）「長江文明の探求，代表：安田喜憲」600 千円

基盤研究(A)(2)　大倉敬宏（分担）「変動するフィリピン島弧：地球物理および地質学的調査・研究、代表：安藤雅孝」 4,400 千円

基盤研究（B）　竹村恵二（分担）「大規模堆積平野縁の第一級活断層に伴う変位地形と地下構造に関する研究，代表：岡田篤正」4,200 千円

基盤研究(B)　田中良和（分担）「３次元深部地殻構造電磁探査システムの研究，代表：茂木透」1,000 千円

基盤研究(C)　大沢信二・由佐悠紀「火山体土壌空隙を介しての火山ガスと大気の相互作用」900 千円

基盤研究(C)　田中良和・橋本武志 「海底電線を用いた九州西部海域の地殻電気構造の研究」700 千円

奨励研究(A)　大倉敬宏「引き裂かれるフィリピン島弧-マコロード回廊生成プロセスの解明-」1,000 千円

奨励研究(A)　鈴木勝彦 「白金-オスミウム，レニウム-オスミウム系を用いた海洋プレートの循環を追う試み」1000 千円

奨励研究(A)　川本竜彦「地球深部条件におけるマグマの分光学」 1,600 千円

奨励研究(A)　橋本武志「自然電位および土壌ガスの確率的トモグラフィによる火山の浅部熱水系の解明」1,400 千円

<u>奨学寄付金等</u>

竹村恵二，（財）地域・地盤・環境研究所「海底活断層の活動度評価に関する研究」2,000 千円

<u>受託研究</u>

鈴木勝彦「白金-オスミウム，レニウムーオスミウム放射壊変系を用いてマントルプルームの発生深度を決める試み」1350 千円

大沢信二「火山体水理構造のマグマ活動への影響の解明」2,388 千円

<u>共同研究等</u>

科学振興調整費 橋本武志（分担），「雲仙火山：科学掘削による噴火機構とマグマ活動解明のための国際共同研究，代表：宇都浩三」1,000 千円

日米科学協力事業　田中良和（代表）・橋本武志（分担）　「火山活動にともなう電磁場の発生機構ー阿蘇とロングバレーの比較研究ー」1,518 千円

地震研究所特定共同研究(B)　須藤靖明・橋本武志（分担）　「すすから光へ：古い地震記象のディジタル化と解析，代表者：中西一郎」1,358 千円

地震研究所特定共同研究Ｂ 古川善紹(分担) 「九州・琉球背弧の深部構造とテクトニクスの研究、代表：鈴木貞臣」1,526 千円

地震研究所一般共同研究　古川善紹　「地震波による九州・別府ー島原地溝帯内火山地域での地殻内流体相の検出」442 千円

教 育 活 動 Education

学位・授業 Academics

学位審査

大倉敬宏
（審査員） 西 潔（博士 京都大学理学研究科）
（審査員） 為栗 健 (博士 京都大学理学研究科)
（審査員） John Makario Londono（博士 京都大学理学研究科）

須藤靖明
（主査） John Makario Londono（博士 京都大学理学研究科）
（審査員） 西 潔（博士 京都大学理学研究科）
（審査員） 為栗 健 (博士 京都大学理学研究科）
（審査員） 伊藤壮介（修士 京都大学理学研究科）

竹村恵二
（審査員） 石山達也 （博士 京都大学大学院理学研究科）
（審査員） Yum Jong-Gwon (博士 Yonsei University, Korea 学外審査員)
（審査員） 伊藤陽之 （修士 京都大学大学院理学研究科）
（主査） 岡橋久世 （修士 京都大学大学院理学研究科）
（審査員） 木村治夫 （修士 京都大学大学院理学研究科）
（審査員） 中 健紘 （修士 京都大学大学院理学研究科）
（主査） 長谷川 真（修士 京都大学大学院理学研究科）

田中良和
（審査員） 小坂和宏（修士 京都大学大学院理学研究科）
（審査員） 大久保綾子（修士 京都大学大学院理学研究科）
（審査員） 笠谷貴史（博士 京都大学大学院理学研究科）
（審査員） 長門研吉（博士 京都大学大学院理学研究科）
（審査員） 為栗 健（博士 京都大学大学院理学研究科）
（審査員） 西 潔 （博士 京都大学大学院理学研究科）
（審査員） John Makario Londono（博士 京都大学大学院理学研究科）
（審査員） 竹内智彦（博士 京都大学大学院理学研究科）
（審査員） 宮下幸長（博士 京都大学大学院理学研究科）
（審査員） 吉村令慧（博士 京都大学大学院理学研究科）
（審査員） 長尾大道（博士 京都大学大学院理学研究科）

講義・ゼミナール

科目	担当教官
（学部）	
地熱学	由佐悠紀・田中良和・竹村恵二・須藤靖明・大沢信二・古川善紹
陸水物理学	由佐悠紀・諏訪浩[1]
火山物理学	田中良和・須藤靖明・大倉敬宏
地殻物理学	竹村恵二
課題演習 D3	岡田篤正[2]・竹村恵二・堤浩之[2]・赤松純平[1]・福岡 浩[1]・岩田知孝[1]
課題研究 T8	岡田篤正[2]・竹村恵二・須藤靖明・堤浩之[2]・入倉孝次郎[1]・佐々

	恭二[1]
考古学特殊講義（文学部）	竹村恵二

（大学院・修士課程）

応用地球科学	岡田篤正[2]・竹村恵二
応用地球電磁気学	大志万直人[1]・田中良和
水圏地球物理学II	由佐悠紀・大沢信二・奥西一夫[1]・諏訪 浩[1]
地球熱学・地熱流体学I	由佐悠紀・田中良和・大沢信二
地球熱学・地熱流体学II	須藤靖明・古川善紹・大倉敬宏・竹村恵二
地球生物圏史セミナーI	増田富士雄[3]・前田晴良[3]・酒井哲弥[3]・竹村恵二・大野照文[4]
第四紀地質学	竹村恵二
地球惑星科学特殊研究	竹村恵二および地球物理学分野全教官

（大学院修士課程および博士後期課程）

応用地球電磁気学ゼミナール	大志万直人・田中良和・橋本武志・神田径[1]
固体地球物理学ゼミナールIV	尾池和夫[2]・中西一朗[2]・大倉敬宏
応用地球科学ゼミナールI	岡田篤正[2]・竹村恵二・堤浩之[2]
応用地球科学ゼミナールII	岡田篤正[2]・竹村恵二・堤浩之[2]
地球熱学・地熱流体学ゼミナールI	由佐悠紀・田中良和・大沢信二・川本竜彦・鈴木勝彦・柴田知之
地球熱学・地熱流体学ゼミナールII	須藤靖明・古川善紹・大倉敬宏・小野博尉・橋本武志・竹村恵二
地球生物圏史セミナーI	増田富士雄[3]・前田晴良[3]・酒井哲弥[3]・竹村恵二・大野照文[4]
水圏地球物理学ゼミナールIII	由佐悠紀・大沢信二・奥西一夫[1]・諏訪 浩[1]・斎藤隆志[1]

（1 防災研究所、2 地球物理学教室、3 地質学・鉱物学教室、4 総合博物館）

野外実習

地熱学野外実習（7月30日～8月4日）

別府：温泉井の温度検層，水質測定

阿蘇：火口湯だまりからの放熱量推定

地球電磁気学課題演習現地実習（8月6日～11日）

講義（他大学）ほか

北田直人	非常勤講師：大阪工業大学
	非常勤講師：大阪女子大学
大倉敬宏	集中講義：熊本大学理学部
小野博尉	非常勤講師：九州東海大学（農学部後半期「地学」）
須藤靖明	集中講義：島根大総合理工学部
竹村恵二	特殊講義：福岡大学理学部（地球圏科学特殊講義）
由佐悠紀	集中講義：九州大学工学部
	特別講義：大分県立看護科学大学

特別講義

小泉尚嗣（産業技術総合研究所グループ長）「地殻活動地下水学」（9月8～10日）

田中　剛（名古屋大学大学院環境学研究科教授）「同位体希釈中性子放射化分析による白金族元素高確度定量の試み」（12月19日）

研修生等

Mr. EmilioAdan TALAVELA(ニカラグァ) 2001/5/10－2001/9/5 JICA 研修生　受入教官：須藤靖明

セミナー　Seminars

BGRL セミナー

2001 年

4 月　13 日　松影香子「北部オマーンオフィオライトにみられる二回のマントル融解過程：海洋から島弧への地殻の進化」

4 月　27 日　Gary Thompson "Introduction to Laser Ablation microprobe techniques"

5 月　8 日　宮崎　隆（新潟大学自然科学研究科）「南インド，タミルナヅ州北部の原生代アルカリ深成岩類の成因と起源-始生代，エンリッチリソスフェアマントルの形成と進化をさぐる-」

5 月　9 日　木村純一（島根大学理学部）「西南日本弧新生代火成活動の時空変化とその成因：フィリピン海プレート沈み込みの再生とその火成活動にはたす役割」

5 月　18 日　本多将俊（JAMSTEC）「中国の乾燥・半乾燥地域に分布する風成堆積物の地球化学的特徴」

5 月　24 日　常青(Chang Qing)（広島大学・理・地球・清水洋研究室）「The title of my seminar is 'Isotopic and geochemical study on the moraines fom Kunlun Mts. and Tianshan Mts., NW China」

6 月　15 日　西村光史（九州大学理学部地球惑星科学科）「大隅花崗閃緑岩体における in situ crystallization」

6 月　22 日　任鐘元（Zhong-Yuan Ren、東工大理学部地球惑星物理）「ハレアカラ海底リフトゾン　2001 年調査に向けて」

7 月　13 日　田村芳彦(JAMSTEC)

7 月　19 日　Li（東京都立大学）"The geochemical signature and origin of platinum-gourp elements in the Earth's upper mantle: New results on mantle-derived xenoliths from eastern China"

10 月　12 日　川本竜彦「安山岩～流紋岩質マグマと H2O の間の超臨界現象のその場観察：超臨界温度とシリカの関係と H2O フルイドとシリケイトの間での 化学組成の分配」

11 月　1 日　鈴木勝彦　「Re-Os systematics of mantle xenoliths in China: Evidence for 1.7Ga melt depletion of China sub-continental lithospheric mantle」

12 月　7 日　柴田知之「中部地方の島弧火山岩の微量元素・同位体組成の時空変化：フィリピン海プレートの役割」

2002 年

1 月　11 日　鈴木由希「珪長質マグマ噴火時の上昇過程-結晶作用・発泡・脱ガスのタイミングと，噴火初期の段階的上昇について-」

1 月　18 日　芳川雅子「幌満かんらん岩体の交代作用」

1 月　25 日　宮崎　隆「鉛同位体比測定に使用するシリカアクチベーターについて」

2 月　1 日　鈴木隆広（北海道立地質研究所　総務部企画情報課　技術情報科）「有珠山噴火による洞爺湖温泉の坑井への影響」

2 月　15 日　川本竜彦　「水を含んだ地球マントルの高温度高圧力条件におけるその場観察：H2Oフルイドに溶け込むシリケイト成分のＭｇ／Ｓｉの圧力変化」

2 月　22 日　杉本　健(九州大学総合研究博物館　研究支援推進員)「Genetic relation between basal

and more felsic magmas found in Unzen volcano, SW Japan」

3月　8日　佐野貴司（富士常葉大学）「オントンジャワ海台のマグマ分化過程（Differentiation processes of Ontong Java Plateau basalts）」

3月　15日　西村光史「雲仙火山のガラス包有物に記録された噴火前の水含有量」

3月　22日　山本順司（東京大学大学院 理学系研究科附属 地殻化学実験施設）「スピネル-レルゾライトに適用できる超高精度地質圧力計の開発」

他機関等

12月　12日　大沢信二　噴気ガスの化学・同位体組成からみた別府温泉の地熱流体の起源及び性状」別府温泉勉強会

学　会　活　動　Activities in Scientific Societies

橋本武志
　運営委員：地球電磁気・地球惑星圏学会
大沢信二
　国際交流・広報委員：日本温泉科学会
須藤靖明
　編集委員：日本地震学会
竹村恵二
　評議員：日本第四紀学会
　編集幹事：第四紀研究
由佐悠紀
　会長：日本温泉科学会
　評議員：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
　大分県温泉地保全検討委員
　新エネルギー財団地化学技術検討会委員
　大分県温泉調査研究会理事
　新エネルギー・産業技術総合開発機構：地熱開発促進調査委員会（白水越地域部会委員）
　大分県天ヶ瀬温泉保護対策検討会委員
　大分県温泉監視調査委員会委員
　京都大学地球熱学研究施設一般公開特別講演講師

小野博尉
　阿蘇町町史編集委員

須藤靖明
　総合学習研究会（熊本県内小中学校先生と２ヶ月１回）
　桜島運営協議会委員
　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
　くじゅう山系（硫黄山）防災協議会委員
　九重山系火山砂防基本検討委員会委員
　火山研究センター一般公開特別講演講師

竹村恵二
　文部科学省　科学技術政策研究所　科学技術動向研究センター専門調査員
　『関西国際空港注水工法検討委員会』委員
　『関西国際空港（二期地区）地盤挙動調査委員会』委員
　『京都市地域活断層調査委員会』委員
　『地震調査研究推進本部地震調査委員会北日本活断層分科会』委員
　『科学技術振興調整費（雲仙火山：科学掘削による噴火機構とマグマ活動解明に関する調査）調査推進委員会評価委員
　『関西国際空港の地盤挙動に関する検討ＷＧ』委員
　『京都盆地地下構造調査委員会』委員
　『大分県地域活断層調査委員会』委員
　『三重県地域活断層調査委員会』委員
　震災対策技術展神戸シンポジウム講師，「京都市の深部地盤構造」（神戸国際会議場，2002 年

2月）
新関西地盤講習会 2002－京都盆地の地盤と地震—講師，「基準ボーリングと京都盆地の地質」（京都市国際交流会館イベントホール，2002年2月）
京都市中京区「防災研修会」講師，「京都盆地と活断層」（京都府立総合社会福祉会館，2001年11月）
京都市東山高校研修講師，「京都盆地に関する最近の話題（地下構造と活断層）」京大理学部地球物理学教室，2001年10月）
西宮市防災講演会講師，「琵琶湖・大阪盆地の成り立ちと活断層」（西宮市，2001年8月）

田中良和
測地学審議会火山部会委員
火山噴火予知研究協議会委員
火山噴火予知研究委員会委員
地磁気観測作業委員会委員
火山研究センター一般公開特別講演講師

由佐悠紀
経済産業省原子力安全・保安院環境審査顧問
NEDO地熱開発促進調査委員会委員
大分県環境審議会委員
大分県自然環境保全審議会委員（温泉部会長）
大分県温泉地保全検討委員会委員長
大分県温泉監視調査委員会委員長
大分県温泉調査研究会会長
大分県天ケ瀬温泉保護対策検討委員会委員長
熊本県苓北町温泉熱活用調査事業調査検討委員会委員長
新エネルギー財団温泉影響予測手法導入調査検討委員会委員長
日本温泉協会学術部委員
別府市ふれあい広場・サザンクロス講師（2001年7月）
歴史と自然を学ぶ会土曜講座講師（2001年9月）
平成13年度地熱開発管理者研修会講師（2002年1月）
京都大学地球熱学研究施設一般公開特別講演講師

オープンハウス報告書（別府）

1. 内容
地球熱学研究施設公開として、別府では講演・施設見学・ポスター掲示・公開実験を企画し実施した。内容は以下のとおりである

講演：別府温泉のしくみ（由佐教授）、青い温泉水の秘密—シリカコロイドの妙技—（大沢助教授）
施設見学：　来訪者20名程度を1グループとし施設構成員1名が引率して、研究内容の紹介を交え、実験室・実験機器・測定装置の解説を行った.
ポスター掲示：　研究内容の紹介を目的に、施設構成員が各自ポスターを作製し展示した。当日は時間の許す限り、各自が解説するよう努めた。
公開実験：　「石を磨いてみよう」，「石って何？」，「マグマを観察する」，「放射線って何？」の4件の公開実験を企画し，それぞれ解説者をおき，来客に説明を行った。

来場者：　362名

2. 参加者・協力者

当日参加者：由佐、大沢、鈴木、柴田、芳川、土屋、宮崎、西村、山田、新名、本多*、常*、ボグダン*、阿部*、米沢*

企画参加者：由佐、大沢、川本、鈴木、柴田、芳川、土屋、宮崎、網田、篠塚*、本多*、常*、ボグダン*、阿部*、米沢*

反省会参加者：由佐、大沢、鈴木、柴田、芳川、土屋、宮崎、新名、篠塚*、本多*、常*、ボグダン*、阿部*

（敬称略、*：共同研究で長期滞在中の海洋科学技術センター職員）

3. 広報

オープンハウス実施の一般への広報は、ポスター・チラシを作成し掲示・配布を行った．また大分県下の各テレビ局と新聞社に協力を要請した。アンケート集計から、それぞれの方法が広報の役割を果たしたことが伺えるが、新聞がもっともその効果が高かったことが分かった．

4. 運営

当日は 2 回の講演を予定し、その間を繋ぐように公開実験・施設見学を用意した。公開実験は常時行い、施設見学は計 6 回のツアー形式で行う予定だった。しかし、予想をはるかに越えるたくさんの来訪者があり、講演会では会場に入れぬ人が多数出たため急遽2回の講演を追加した。また、施設見学も予定回数を大幅に増やした。

5. 各企画について

講演会は会場に入れなかった人が多数出た．講演を目当てに訪れた方も多数いたので、会場設定に工夫を凝らす等の工夫が必要かもしれない。ポスターの展示は、資金がなくありあわせの物（ホワイトボード・事務用掲示板など）を寄せ集めて、展示板を作った。そのため展示スペースが限られ、両面にポスターを貼ったため、狭い廊下を二分する形となってしまい通行も困難な状態が生じた。熱心に見てくれる人が多数いたこと、解説をはじめると多くの人が集まってきてくれたことを考えると、見学のしやすさ及び万が一の事故が起こった場合の安全面で、問題があったと考えられる。従って今後、ポスター掲示板の購入またはレンタルをしてスペースを広げる必要がある。

公開実験に関しては、各実験に最適な場所を選択して行った。しかし、相互に関連させて説明することでより理解しやすいものがあった（例えば、石を磨いてみようと岩石の観察）にもかかわらず、それらの場所は離れていた。次回からは、可能なら各実験の系統性を保てるような、場所の設定を検討したほうが良いだろう。また、ありあわせのもので実験を用意したためディスプレーが貧弱で、それを担当者の解説で補うよう努力したが、来訪者の多さのため全ての人に十分解説することができなかったことが危惧される。

6. アンケート

住所	人	年代	人	%	どう知ったか	人	%
市内	48	幼稚園	4	5.8	ポスター	3	4.2
市外	19	小学校	4	5.8	チラシ	5	7.0
		中学校	2	2.9	テレビ	4	5.6
		高校生	7	10.1	新聞	37	52.1
		20 代	2	2.9	人に聞いて	19	26.8
		30 代	4	5.8	他	3	4.2
		40 代	14	20.3			
		50 代	13	18.8			
		60 代	9	13.0			
		70 代	9	13.0			
		80 代以上	1	1.4			
		計	69		計	71	

講演		わかりやすかった	わかりにくかった	どちらとも言えない	計
	別府温泉の仕組み	26	2	5	33
	青い温泉水の秘密	13	2	5	20
		面白かった	面白くない	どちらとも言えない	
見学ツアー		41	1	5	47
公開実験	マグマの観察	40	1	1	42
	放射線ってなに	35	4	4	43
	石ってなに	37	0	1	38
	石磨き	31	1	5	37

火山研究センター平成１３年度一般見学会（オープンハウス）の概要報告

（1） 一般見学会の概要

目的： 一般市民，特に地域住民・関係機関に，当センターの活動内容を広く知ってもらうことで，センターに対する関心・理解を得る．また，社会への学術的知識の還元・啓蒙を図る．

開催日時： 平成１３年度１１月１０日（土） ９：３０～１６：００

内容：

- ポスター展示（約２５点）による研究内容の紹介・火山学の一般向け解説
- 公開実験（地震計の稼働・光波測距儀による測量・磁力計による岩石の磁化測定）
- 施設備品展示（旧型地震計等各種観測装置の展示・解説）
- 火山に関するビデオの上映（随時）
- 火山に関する書籍の閲覧供与（随時）

- パソコンによる展示（２点）（九州の地震活動リアルタイムモニター，火山と地震に関する教育ソフト）
- 特別講演（２件：　須藤靖明教授，田中良和教授　各１時間）
- 見学者用パンフレット（大人用，子供用）を配布
- 阿蘇・九重火山の絵はがきを記念品として作成・配布

社会への告知の方法：
- A3版ポスターとA4版チラシを作成．阿蘇郡内の役場・温泉・見学施設等を中心に配布．
- インターネットホームページによる公示．
- 新聞（西日本新聞）
- 地元タウン情報誌（mocos）

（２）　見学者に関する集計

見学者数：　８７名
地域別集計：阿蘇郡内からの見学者が約半数を占めた．県外からの見学者も数名あった．
年代別集計：広い世代にわたって見学者が訪れたが，車の運転が出来ないためか中学生・高校生の見学者はなかった．今後はこれらの年代層が来やすい開催方法を考える必要がある。

（３）　マスコミによる報道
（事前報道）西日本新聞
（事後報道）熊本日日新聞，NHKテレビローカルニュース

来 訪 者 Vistors

【別府】

2001年

4月 5日　永野・中井（別府市誌編纂事務局）
4月 9日　沖政新一（大分地方気象台台長）
4月 10日　安東正憲・渕祐一・宗安英亜（大分県生活環境課）
4月 10日　宮田佳樹 (東大海洋研，2日間)
4月 13日　河村建一（別府末広郵便局）
4月 14日　入来正躬（山梨県環境科学研究所）
4月 19日　武富悟（西日本新聞）
4月 20日　別府消防署救急隊員 (救急法講習)
4月 21日　巽好幸・佐藤佳子（海洋科学技術センター）
4月 23日　斎藤治郎（別府市観光協会），永野・中井（別府市編纂事務局）
4月 26日　財津秀邦（画家）
5月 1日　田中敏雄（ビーコンプラザ）
5月 7日　木村純一・井上・国清 (島根大，14日間)
5月 8日　巽好幸・竹岡美子（海洋科学技術センター）
5月 11日　本田孝洋（大分合同新聞）
5月 21日　佐藤佳子（海洋科学技術センター）
5月 24日　常青 (広大，2日間)
5月 30日　川本・田中（理学部用度掛）
6月 6日　阿南敏喜（別府市文化財調査員）
6月 10日　任鐘元（東京工業大学理学部地球惑星科学科博士課程2年、7月29日まで）
6月 11日　服部雄次 (広大，17日間)
6月 14日　荒金正憲（別府大学名誉教授）
6月 15日　森山清治（大分出光地熱）
6月 19日　三浦祥子（ハヌマン）
7月 9日　山崎恭子（人間環境学研究科，10日間）
7月 12日　巽好幸・西村一 (JAMSTEC)
7月 17日　海老原充・LI Xiaolin (都立大，3日間)
7月 30日　財津秀邦（画家）
7月 31日　京大理学部学生8名（地熱学野外実習：3日間）
8月 2日　山崎恭子（人間環境学研究科，5日間），矢口・服部（電源開発）
8月 8日　大分県立上野丘高等学校一行（藤井教諭，1年生20名）
8月 9日　ロータリー米山留学生一行（20名）
8月 20日　服部雄次 (広大，30日間)
8月 27日　日下部実（岡山大固体地球研究センター）
8月 31日　後藤憲志（別府市民）
9月 3日　Chi Vinh Ly (広大，6日間)8月21日　国際地形学大会一行（5名）
9月 7日　別府市立山の手中学校生徒約60人
9月 8日　小泉尚嗣（産業技術総合研究所：集中講義，3日間）
9月 12日　清水洋 (広大，2日間)
9月 17日　有吉・松山（応用地質）
9月 18日　衛藤秀史（大分合同新聞）
9月 19日　工藤・一万田（大分県野津原町）
9月 20日　渕祐一（大分県生活環境課）
9月 27日　巽好幸・鳥居 (JAMSTEC，2日間)
10月 1日　荒川ほか1名（大分県山国町教育委員会：）

10月4日　伊達二郎（新エネルギー財団）
10月5日　工藤・一万田（大分県野津原町）
10月9日　服部雄次 (3日間)
10月22日　巽好幸・宿野・佐藤佳子 (JAMSTEC，2日間)
10月22日　千々谷眞人・巽好幸（海洋科学技術センター）
10月23日　三輪節生（朝日新聞）
10月24日　渡邊慎也（明豊高等学校）
10月25日　JICA（地熱エネルギーと環境科学）研修生一行15名
10月29日　後藤忠宏（大分県広報広聴課）
10月31日　宿野浩司・鳥居久世（海洋科学技術センター）
11月1日　並松史郎（名古屋大学工学研究科）
11月5日　鎌田・金子・学生8名（京大総合人間学部）
11月5日　藤内教史（大分合同新聞）
11月6日　北岡・山口・学生2人（岡山理科大学），松影（茨木大学）
11月8日　渡辺誠司（別府市建設部），巽・浜谷・武岡（海洋科学技術センター），田嶋章二・浜口雅英・山崎秀典（熊本県苓北町），西村光史（九州大学：）
11月9日　大野保治（大分大学名誉教授）
11月17日　明豊高校一行（渡辺教諭、生徒47名）
11月19日　阿蘇山測候所一行4名
11月26日　松山・有吉（応用地質）
11月27日　古幡恵一（ビーコンプラザ）
11月30日　東邦大学　恩田裕二（10日間）
12月4日　青木正年（大分県別杵速見地方振興局）
12月5日　XU Jifeng (中国広州地球化学研究所，60日間)
12月7日　巽好幸 (JAMSTEC，3日間)
12月11日　藤永公一郎 (山口大，13日間)
12月13日　仙田量子・南雅代 (名大，11日間)
12月17日　渕祐一（大分県生活環境課），中野護（読売新聞）
12月18日　田中剛（名古屋大学：特別講義3日間），堀江正治名誉教授
12月21日　荒木教授・竹本教授・小畑教授・福田助教授（教官会議）
12月22日　竹村恵二（京大地球物理）
12月25日　渕祐一（大分県生活環境課）
12月26日　巽好幸（海洋科学技術センター）

2002年

1月8日　川野田実夫（大分大学），斉藤治郎（別府市観光協会），小原猛（南立石小学校）
1月16日　溝口（別府市商工課）
1月17日　池部・安部（別府市観光経済部）
1月18日　小笠原・工藤（テレビ大分），森（福岡放送）
1月21日　テレビ大分撮影班一行（4名），有吉・松山（応用地質），野邑（ボーゲンファイル）
1月22日　大分放送撮影班一行（3名）
1月28日　阿部王一（俳人協会）
1月29日　鈴木隆広（北海道立地質研究所：10日間），武内・川島（西日本環境エネルギー）
1月30日　陳中華（台湾中央研究院地球科学研究所）
1月31日　新出・守山・池田・山本（京大施設部）
2月25日　山田俊秀（別府市教育委員会）
2月28日　加藤・日下部・内梨・志水（京大経理部）
2月28日　XU Jifeng (中国広州地球化学研究所，92日間)
3月2日　川田（別府市民）
3月7日　東邦大学　高松信樹、他2名（7日間）
3月7日　滝川・奥林・三谷（京大研究協力部）

3月12日　高畑武志（京大地球物理学教室技官）
3月17日　島崎邦彦（東大地震研），松田時彦（西南学院大），千田　昇（大分大学），水野清秀（産業技術総合研究所），松山尚典（応用地質），平田・大石（西日本技術開発）（2日間）
3月19日　西川・寺岡・西村（京大施設部）
3月27日　巽好幸（海洋科学技術センター，4日間）
3月29日　天本敬吾（九州電力）
3月29日　金庫検査　広瀬・堀内（経理部）；森（経理掛）
3月29日　北田奈緒子（財：地域・地盤・環境）
3月30日　堀田平（海洋科学技術センター）
3月30日　清水洋 (広大，2日間)

【阿蘇】
2001年
4月 2日　Martin Meuller氏＋1名　見学
4月 6日　加茂幸介，久保寺章，園田，多中
4月13日　気象庁地磁気観測所鹿屋出張所から1名
4月17日　県防災消防課　2人
5月 7日　古川邦之（京大人間環境学研究科）　5/15まで。
5月15日　Emillio氏（ニカラグア）研修生として来研
5月23日　九地整　郡山氏
5月30日　用度掛　田中氏　物品検査
6月13日　Kostadinov Mladen(東大生産研)、Cao　Long・Alexander KHEGAY(JICA研修生)、岡野礼子（JICA）
6月30日　ネオサイエンス，城森明氏来研
7月 4日　九東海大　平川教授他6人
7月17日　森・鈴木（東工大）九重観測のため（7/23まで）
7月18日　金嶋・高木・岩村・George（東工大）・山本（東大）（7/23まで）
7月19日　川勝（東大）（7/22まで）
8月 1日　地熱学実習生（8/3まで）
8月 1日　古川邦之（京大人間環境学研究科）　8/10まで。
8月 1日　行竹洋平（京大防災研）他9名
8月19日　Jean-Claude THOURE夫妻（Blaise-Pascal大）、Patrich WASSEMER（Strasbourg大）、諏訪（防災研）
8月 6日　地球電磁気学3回生4名（8/11まで）
8月 7日　鎌田（京大総人）、田上高広・山田国見（京大理）　8/10まで。
8月17日　立野ダム工事事務所中山氏
8月22日　阿蘇グリーンストック小学生15名見学
9月14日　藤澤雅章・米満利行・笠原隆（施設部）、中山（立野ダム工事事務所）(9/15まで)
9月19日　立野ダム補償工事定例打ち合わせ会の為多数来研
9月28日　島根大　沢田氏他20人（9/29まで）
10月11日　西園（西日本技術開発）
10月12日　独国営テレビ　ＺＤＦ4人
10月25日　中西一郎（地球物理学教室）他1名（10/28まで）
10月26日　坂中（秋田大）　（10/28まで）
10月27日　地科研　井川氏
10月29日　元JICA　広部氏
11月 3日　鎌田・金子（京大総人）ほか学生8名（11/5まで）
11月 5日　西川・安本（用度掛）物品検査（11/6まで）

11月7日　大月崇綱（西日本新聞），矢嶋秀樹（朝日新聞）一般公開の取材
11月11日　M. Johnston (USGS)（11/13まで）
11月12日　酒井（京大総人）、乙部（福岡大）、斉藤・須田（京大人間環境学研究科）（11/14まで）
11月13日　山本希（東大地震研）高木憲明（東工大）（11/15まで）
11月15日　砂防センター　伊藤氏他2
11月22日　京繊大　木原氏他8
11月26日　坂中伸也（秋田大）阿蘇の観測のため（11/30まで）
11月29日　上村商会（産廃処理）
12月1日　元名大　樋口氏
12月13日　宮縁育夫（森林総研），池辺伸一郎（火山博物館）来研，新坑道の見学
12月13日　秋田大　筒井氏　他2名（12/14まで）
12月14日　地磁気観測所，牧　広篤技術課長
12月27日　秋田大　筒井氏　他2名（12/28まで）
12月20日　立野ダム補償工事定例打合会

2002年

1月15日　立野ダム補償工事定例打合会
1月22日　片桐和子・小泉秀雄・石川敏和・小野塚朗ほか1名（文部科学省メディア教育開発センター）
1月31日　Prof. Francois Holtz,Dr. Harald Behrens, Mr. Roman Botcharnikov (Hannover Univ.), Mr. Renat Almeev（島根大），佐藤博明（神戸大）、熊谷（防災科研）他1名
2月6日　鍵山・金子・桧山・他1名（東大）熱赤外測定（2/7まで）
2月13日　NTT-TE OCN回線のチェック
2月14日　九州管区気象台　5人　火山監視センター設立のため
2月15日　地科研　江坂氏　土砂流出リモセンの件（2/19まで）
2月15日　白山工業2名
2月18日　江浦・井手（国際電子工業）、下泉政志（ポリテクカレッジ北九州）
2月19日　川合忍・田村長生・田中ゆかり・山崎猛司（経理部）
3月4日　木村善衛（フリッチュ・ジャパン）
3月10日　東大理地殻研　野津氏他4名（3/12まで）
3月12日　小泉岳司（気象庁）、早水かおる（JICS）、JICA研修生7名
3月13日　高畑武志（京大地球物理学教室技官）
3月15日　国際電子工業3名（3/20まで）
3月16日　JICA　地理院研修生　10名
3月18日　西（広島市立大）
3月19日　Gensane Olivie（東大）夫妻（3/20まで）　セミナー＋見学
3月25日　高橋忠世・滝井洋一・小山茂（東大地震研）
3月26日　大野正夫（九大）温泉水サンプリングのため（3/28まで）
3月27日　鴨嶋武忠（理学部事務長）他事務方4名来研（立野ダム補償工事引き渡し式）
3月27日　気象庁九州管区センター長　他2名
3月27日　大久保康邦（産総研主任研究員），松島潤（産総研研究員）
3月28日　事務方3名来研．金庫検査のため
3月29日　大分地裁　修習生　9名