サンゴ礁における炭酸系ダイナミクスと地球環境の関係

メタデータ	言語: 出版者: 大森保 公開日: 2009-07-21 キーワード (Ja): 温暖化, サンゴ礁, 二酸化炭素, 炭酸系, ラジカル, 地球環境変動, 光合成, 石灰化, ダイナミクス, 時系列観測, 生物生産, 白化 キーワード (En): photosynthesis, global environment, carbonate system, dynamics, coral reef, calcification, carbon dioxide, global warming 作成者: 大森, 保, 新垣, 雄光, 又吉, 直子, 棚原, 朗, Oomori, Tamotsu, Arakaki, Takemitsu, Matayoshi, Naoko, Tanahara, Akira メールアドレス: 所属:
URL	http://hdl.handle.net/20.500.12000/11327

3） 石西礁湖のサンゴ礁・竹富海底温泉・熱水活動調査

平成 15 年 石西礁湖竹富温泉調査（大森保、野口拓郎、佐野伸哉）
沖縄本島山田温泉調査（大森保、野口拓郎、佐野伸哉）
平成 16 年 石西礁湖竹富温泉調査（大森保、野口拓郎、佐野伸哉）12 月
（大森保、佐野伸哉、田原）、3 月

平成 15 年 水曜海山調査、黒島海丘調査（平良直人）
平成 16 年 ファンデフカ海嶺掘削計画航海 IOPD（野口拓郎）

1）竹富海底温泉とサンゴ礁

石垣島と西表島の間に広がる石西礁湖は、国内最大規模のサンゴ礁であり、多種類のサンゴが生息する琉球列島の生物多様性を象徴するフィールドである。

石西礁湖の東部、竹富島の北東約500mの海底に竹富島海底温泉と呼ばれる熱水噴出域が存在する。噴出口周辺は直径50m、深さ20m ほどの凹地になっており、その周辺部には、死んだ枝サンゴの破片が堆積している。

噴出口からは最高約70℃の温水や温泉ガスが噴出している。温泉ガスの主成分は、メタン、酸素、窒素、二酸化炭素であり、地球温暖化に影響する気体を含有する。その他にも水素、硫化水素、炭化水素やヘリウム、ラドンなどの希ガスを含んでいる。

温泉水とガスの地球化学的調査が1976 年と1982年に行なわれ（兼島ら1983）熱水循環過程の解明や西表島群発地震、沖縄トラフの海底熱水活動との関係を明らかにすることを目的として調査が続けられている（大森1987、大森ら1991など）。

噴出口周辺では、海底熱水活動域に見られる硫化水素や重金属などを使ってエネルギーに変換するバクテリア群集が確認されており、竹富島海底温泉は化学合成生物群集と光合成生物群集が共存する、世界でも非常に特殊な浅海域の熱水活動域として学術的に注目されつつある。

琉球大学21世紀COE「サンゴ礁島嶼系の生物多様性の総合解析」に参画している海洋開発研究機構（JAMSTEC)の生態系グループとの共同プロジェクトとして、竹富海底温泉周辺のさんご礁生態系における炭酸系の成り立ちと温泉活動の影響について解明するための調査をおこなった。

石西礁湖・竹富海底温泉調査

2004.11.28-12.5

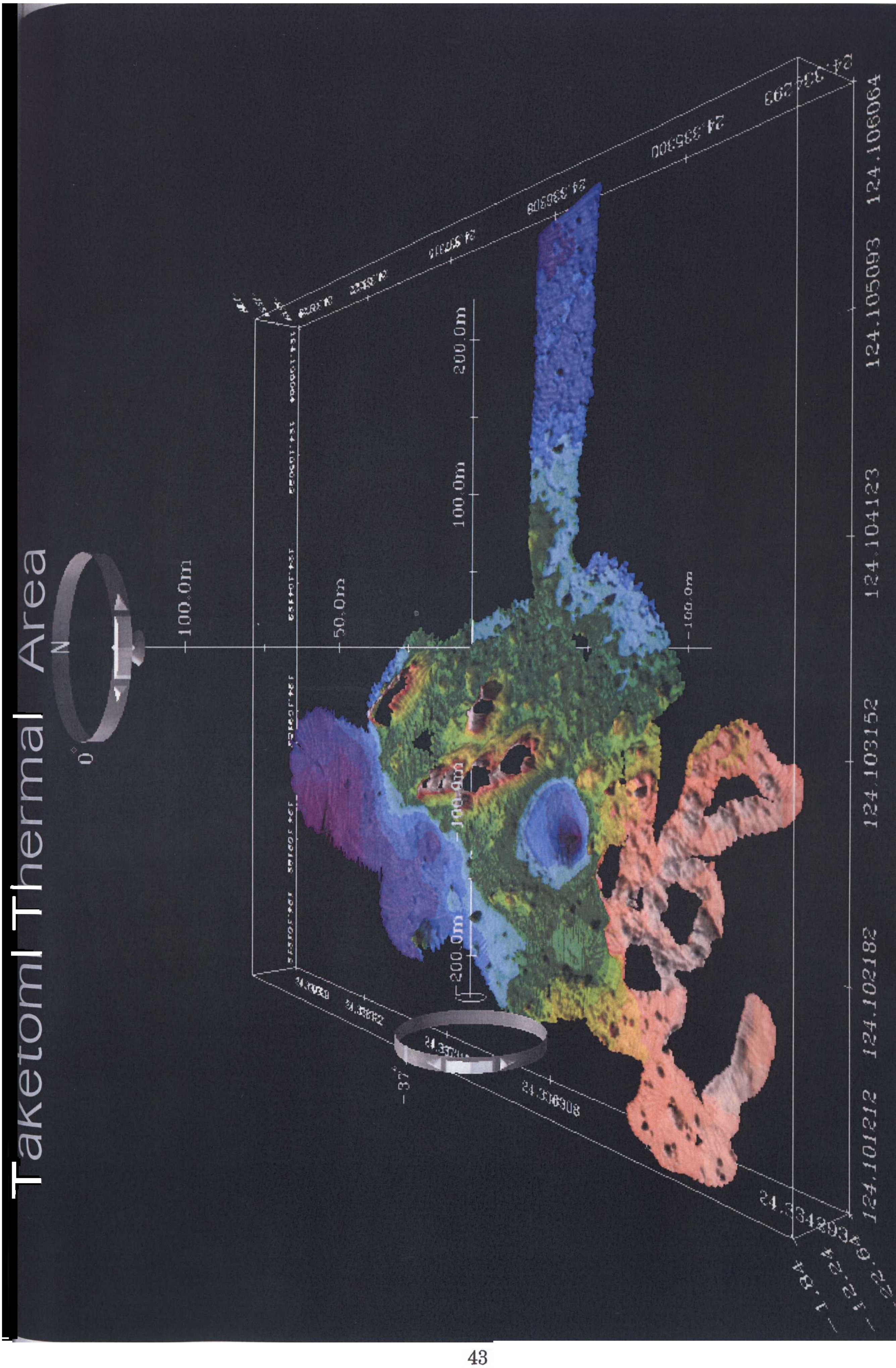
ROV調査（園田・嘉陽・宮城・大城）

物理化学環境（大森・古島）
・地形計測
・水温・地中温度
・流向流速
・熱水採取
・堆積物コア採取

微生物（高井・布浦・吉田・山本）
・微生物量
・現場測定
・好熱性原核生物の検出

ベントス（土田）
・堆積物採取


Taketomi Thermal Area


Taketomi Thermal Area
N
100.0m
50.0m
100.0m
200.0m
-100.0m
-100.0m
200.0m
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124.103152
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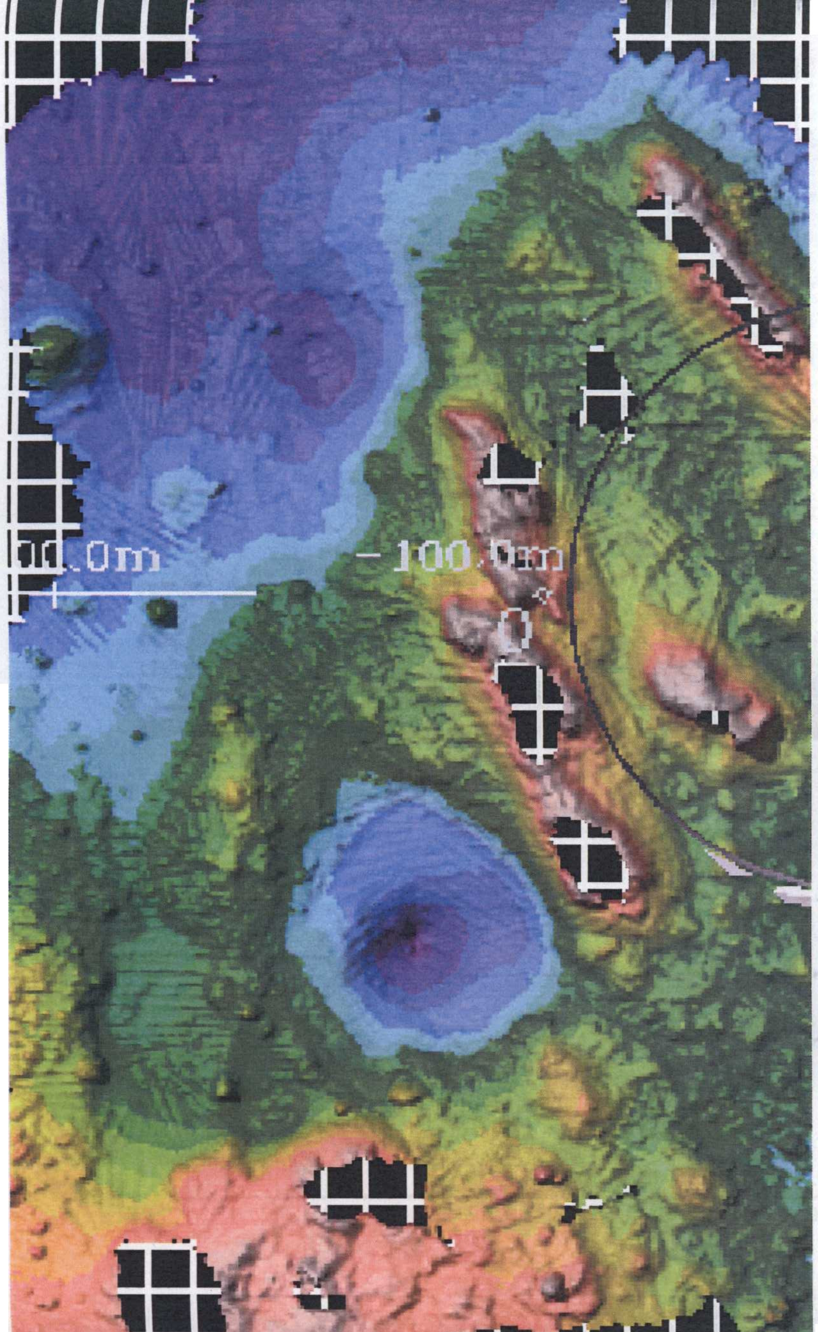


1 grit = ca. 13 m

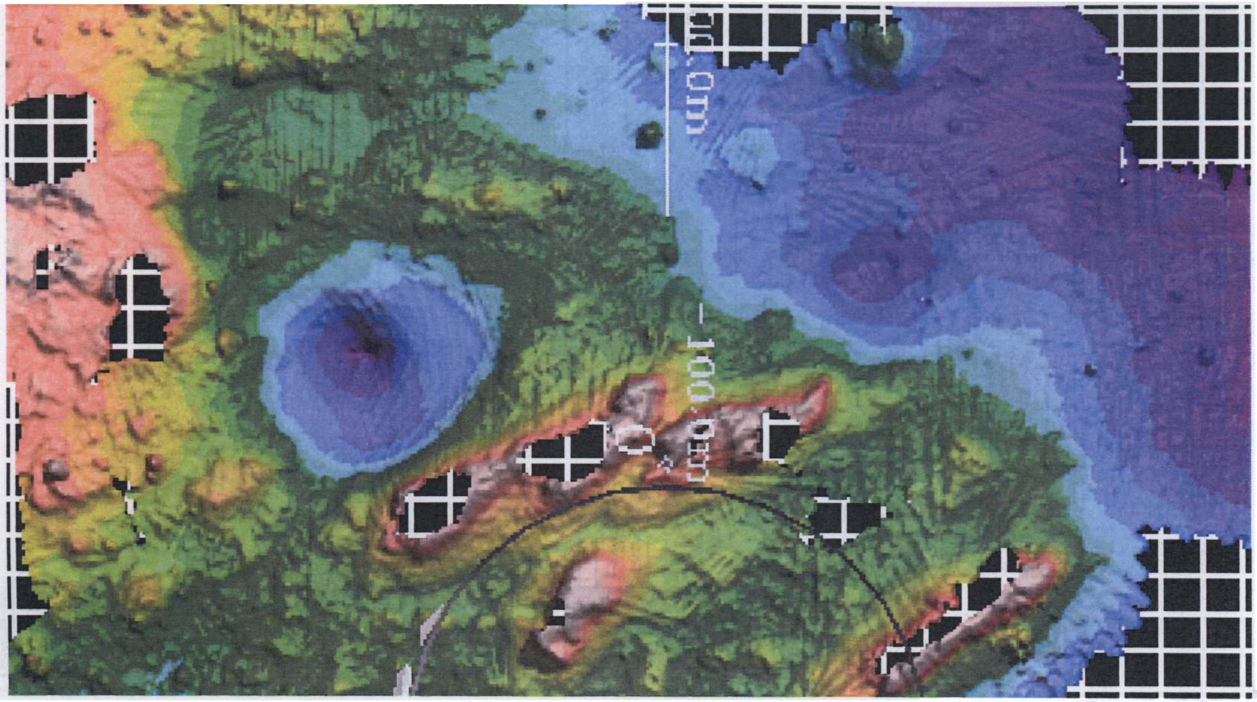
Taketomi Thermal Area

The submarine hot spring, spouting from 20m depth bottom of caldera-like topographic feature, located at 1.2 km off Taketomi jima East side.

Position
21.336000 N (21° 20.16 N)
124.102500 E (124° 06.15 E)
Depth : 15-20m

The thermal water spouting is slow with intermittent bubbling. The gas-bubbles contain methane (60-70%), nitrogen (20%), oxygen (2-7%), carbon dioxide (1-2%) and hydrogen sulfied. It is visible even at the sea surface. The highest temperature recorded at the bottom area is 80°C. (T. Oomori)

Sea-floor Temperature



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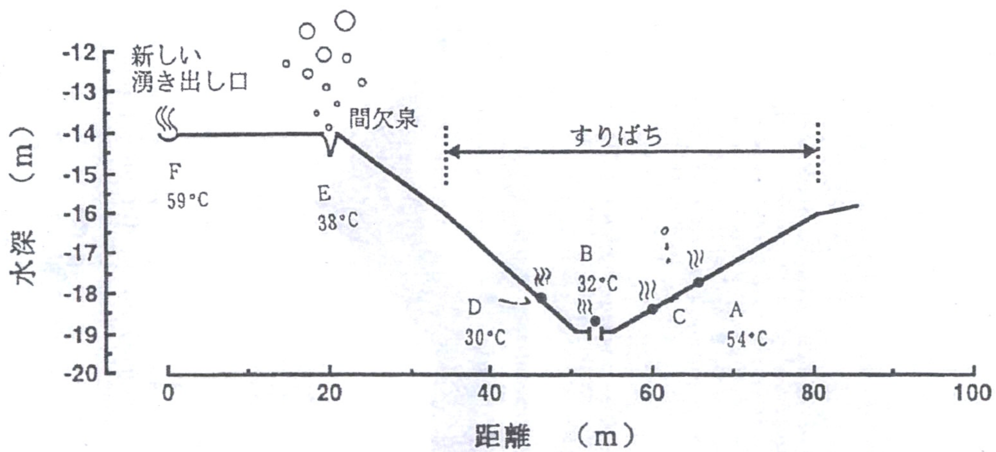

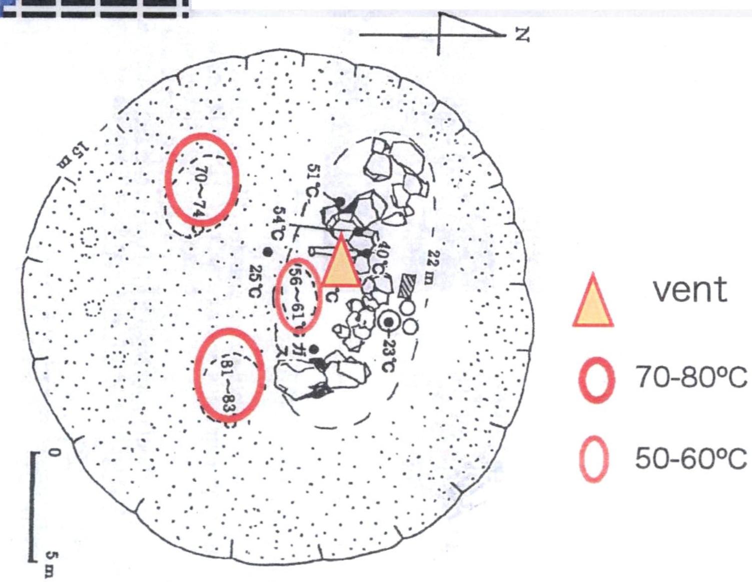

（大森保：1991,1993）

Geochemical study on the Taketomi submarine hot spring ~influences for the coral reef ecosystem~

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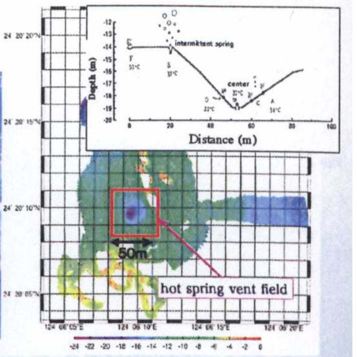
Introduction

Taketomi submarine hot spring was located at bottom of Sekisei lagoon (about 20m below sea surface), 500m east from Taketomi island (Fig.1). It is noted that hydrothermal fluid and gas are venting in this hot spring field, where fringing coral reefs are widely distributed. In the shallow hot spring filed, chemosynthetic organisms can habitat similarly to deep sea hydrothermal vent field. We are interested the relationship between the chemosynthetic and photosynthetic ecosystems. Firstly, we observed on the physical and chemical condition of the Taketomi hot spring and discussed on the detection of chemosynthetic activities.



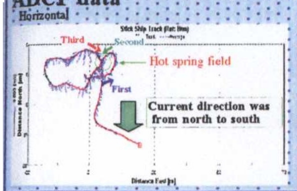
Methods

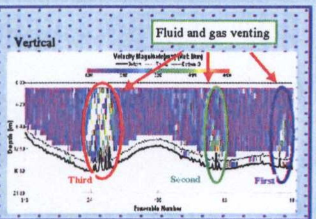
- ADCP (Acoustic Doppler Current Profiler)
→measurement of 3D current direction and velocity
- GC-TCD(gas chromatography-thermal conductivity detector)
→chemical composition of gaseous sample(CH_4,H_2,N_2,O_2,C_2H_6)

- Fluid chemistry
  - Nuetrients (NH_4^+, SiO_4^{2-}): colormetric analysis
  - Major cations(Na^+,Mg^{2+},K^+,Ca^{2+}): atomic absorption spectrometry
  - Cl^- concentration: $AgNO_3$ titration
  - SO_4^{2-}: Ion chromatography
  - pH, Alkalinity: pH meter (Gran-plot titration method)
  - mercury concentration: cold vapor atomic absorption spectrometry

Results

ADCP data



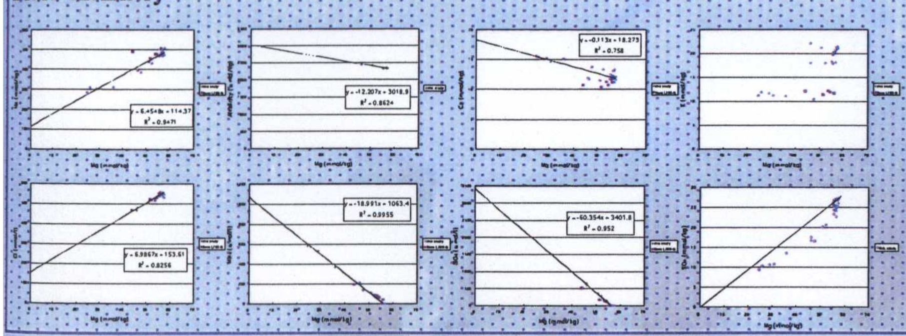


Gas sample

	intermittent spring A	intermittent spring B	Center No.1	Center No.2
CH_4	68.5	69.5	69.0	68.2
N_2	29.0	28.1	29.2	30.1
CO_2	1.86	1.68	0.445	0.458
O_2	0.698	0.73	1.27	1.23
H_2	0.0149	0.0105	0.00817	0.0112
He	n.d	n.d	0.000651	0.000553
C_2H_6	0.0172	0.0160	0.0142	0.0135
C_2H_6/CH_4	0.00025	0.00023	0.00020	0.00020

Major components of gas sample were CH_4(68~70%), N_2(28~30%), CO_2(0.4~1.9%) and O_2(0.7~1.3%). He, H_2 and C_2H_6 were detected as a minor components.

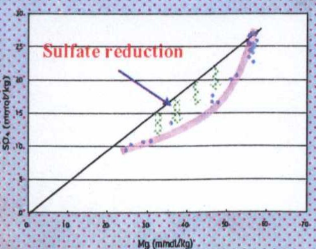
Fluid chemistry



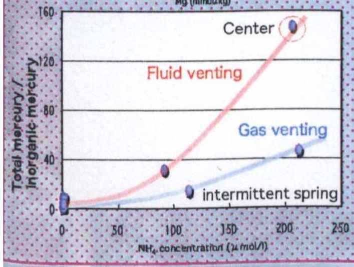
The chemical compositions of end-member hydrothermal fluid (extrapolation of Mg concentration to 0 mmol/kg) were as following; Na^+ 114 (mmol/kg), Cl^- 154 (mmol/l), Alkalinity 3.02 (mmol/kg), NH_4 1060 (mmol/l), Ca^{2+} 18.3 (mmol/kg), SiO_4 3.40 (mmol/l), and SO_4^{2-} 0 (mmol/kg), respectively.

→These results suggested that this hot spring fluid were not simple mixture of hydrothermal fluid and seawater but contamination of the fresh water. The existence of fluid less than 20 km below sea floor is reported (Irabu, 2005). It will be one of the possible fluid sources of the high temperature low salinity fluid.

Discussion

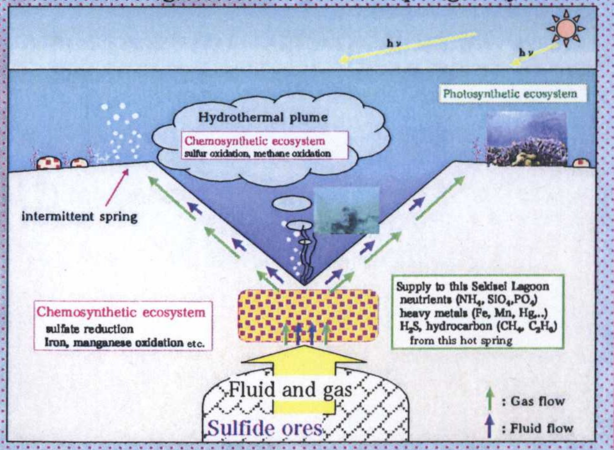


SO_4 concentration in sea water lies below the mixing line of sea water and hydrothermal waters, which suggested that SO_4 reduction by microorganisms activity in Taketomi submarine hot spring field.



It was reported that mercury sulfide were precipitated at >5m below seafloor in this field. The interaction between the mercury sulfide (containing sedimented inorganic mercury) and chemosynthetic microorganisms cause to this mercury methylation (it is reported the sulfate reducing bacteria participate the mercury methylation).

Schematic diagram of Taketomi hot spring ecosystem



※It is found that both photosynthetic and chemosynthetic organisms habitat very closely in the Sekisei lagoon.

Future work

The following discussions will be expected on this hot spring;

1. To clarify the relationship between chemosynthetic and photosynthetic ecosystem in this hot spring.
2. To clarify the influence such as heat, nutrients, and heavy metals to Sekisei Lagoon.
3. To clarify the source of heat and fluid. (Where does heat and fluid come from? Magma? Dehydration of rock minerals?

Acknowledgements

This work was supported by the 21st Century COE program of the University of the Ryukyus. This work has been performed by using facilities of Instruments Research center, Univ. of the Ryukyus (atomic absorption spectrometry). We thank Dr. Y, Furushima, Dr. K, Takai, Dr. T, Nunoura, Dr. S, Tsuchida (JAMSTEC), Dr. A, Sonoda, Mr. S, Kayou, Mr. T, Miyagi, Mr. H, Miyagi, Mr. S, Miyagi (GODAC) , Mr. T, Higuchi (Univ. of the Ryukyus) and "Uminchu" divers for the sampling. And we also thank Dr. H, Fujimura, Mr. K, Okada, Ms. T, Kuwano for sample analysis.