

キクメイシ科化石サンゴを用いた

16,000年前の琉球列島域の氷期古海洋環境復元

2008年3月 地球海洋環境学分野 56727 三島真理

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1. はじめに

サンゴ骨格には海洋環境(海水温、塩分など)の記録が刻まれている。造礁サンゴの骨格には、しばしば高/低密度が対になって年輪が形成されており、これを横切るように成長方向に沿って種々の安定同対比、微量金属元素測定などの化学分析を行えば高い時間分解能での環境復元が可能である。本研究では琉球列島沖で採取された16,000年前のキクメイシ科化石サンゴ(MYK90)の骨格について酸素、炭素同位体($\delta^{18}\text{O}$, $\delta^{13}\text{C}$)及びストロンチウムカルシウム比(Sr/Ca)分析を行った。当時の環境は発達した氷床の影響で海水面が現在より約100m低かったとも言われ、氷期のサンゴ化石は収集が困難であるためこのMYK試料は非常に貴重である。また、研究対象地である琉球列島は陸水と黒潮の両方から影響を受ける場所であるため古海洋学的に重要な海域と考えられてきた。本研究は西太平洋で信頼性の高い海水温と塩分をキクメイシ科化石サンゴから復元した初の報告である。最終氷期のアジアモンスーンと呼応した海洋環境についても議論する。

キーワード: サンゴ 同位体 氷期 Sr/Ca

2. サンゴ試料及び対象地

キクメイシ科の化石サンゴ、(サンプルID:MYK90)は24°43'N, 124°3'E 北緯24度43分、東経124度3分の地点で宮古島近海で採取された。(Fig. 2.)時代は 16.17 ± 0.52 kaで、その骨格には明瞭な年輪が見られる(Sasaki *et al.*, 2006)。またこの化石試料と比較考察するため、小笠原諸島父島で採取されたキクメイシ科サンゴ(CJK01)も解析された。

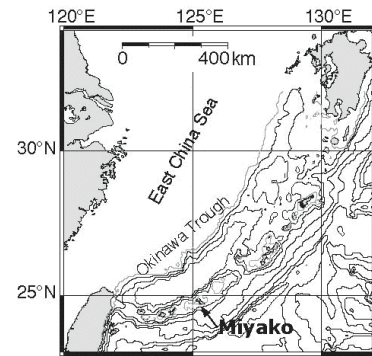


Fig. 1. Study Site

3. 方法

$\delta^{18}\text{O}$, $\delta^{13}\text{C}$ 及びSr/Caの測定のためサンゴ骨格から成長軸に沿って200 μm ごとに一点90 μg -110 μg の粉末をサンプリングし、104サブサンプルがMYKから、60サンプルから現生CJK01かた得られた。これらはSST及とSSSの推定に使われる。

3-2) $\delta^{18}\text{O}$, $\delta^{13}\text{C}$ およびSr/Caの測定

誘導結合プラズマ質量分析法(ICP-MS)によって $\delta^{18}\text{O}$, $\delta^{13}\text{C}$ が、誘導結合プラズマ発光分析法によってSr/Caが分析された。

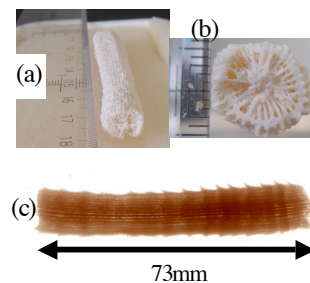


Fig. 2. Faviidae fossil coral MYK90 collected from the Miyako Islands. Photos of overview (a), cross-section (b), positive X-ray image (c).

4. 結果および考察

Fig. 3にMYK90, CJK01それぞれから得られた水温と塩分の指標である酸素同位体比と、水温のみの指標であるSr/Caデータを示す。化石MYKサンゴデータの全体の平均値は、より寒冷/高塩分環境を示唆した。また16kaにおける明瞭で規則的な季節性が見られたがその振幅は先行研究に見られるサンゴに記録された結果と比較すると小さかった。これは骨格内で環境記録を平均するような作用が働いていたからではないかと思われる。

年平均の $\delta^{18}\text{O}$ 、Sr/Caデータについては、どの属のサンゴも比較的似たSSTとの相関が似る知られている。そこで、化石MYKサンゴを用いた水温及び塩分の濃度の推定はSSTとの相関平均化作用を考慮し、Sr/Ca対SSTについては $-0.0600 \text{ mmol/mol } ^\circ\text{C}^{-1}$ 、 $\delta^{18}\text{O}$ については $-0.022\text{‰}\text{‰}^{-1}$ という、サンゴ骨格気候学において広く用いられている値を適用した (Correge, 2006)。

結果、当時の琉球列島海域ではSSTが約 5°C 低く、塩分が $\delta^{18}\text{O}$ に換算して約 0.2‰ 高かったと推定された。これは、16 kaはLGM (最終氷期の最寒冷期) 後ではあるがかなり寒冷な環境であったことと、夏の降水減少冬の東アジアモンスーンが強化により、東シナ海東部が高塩分環境にシフトしていたのではないかとと思われる (Xian *et al.*, in press)。また、当時は氷床が発達して海面が低かったため、東シナ海西部では中国大陸の河川紀元の陸水の影響で低塩分環境だったと報告されている。従って対象地に関する16 kaの陸水の影響は琉球列島には及んでいなかっただろうと考えられる。

References

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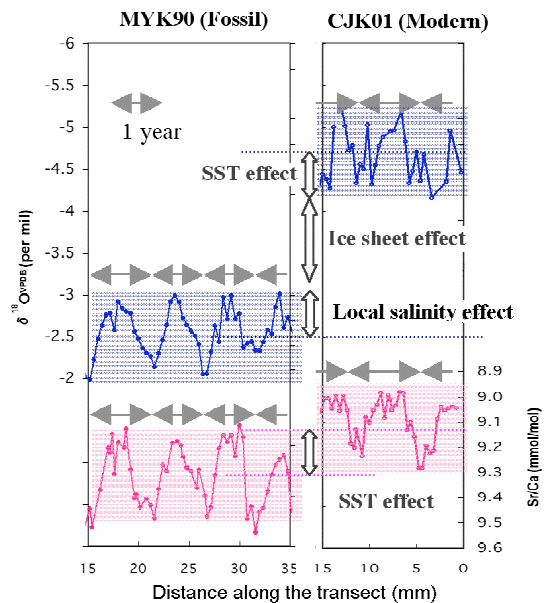


Fig. 3 Data distribution of fossil coral MYK90 (left) and modern coral CJK01 (right). Solid and open profiles show Sr/Ca (mmol/mol) and $\delta^{18}\text{O}_{\text{VDPA}}$ (per mil), respectively. Open arrows show the components responsible for the gap between fossil and modern corals.

Reconstruction of paleoenvironment at 16 ka in the last glacial period by Faviidae coral collected from Ryukyus, southwestern Japan

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1 Introduction

Coral skeletons have been providing powerful archives of modern and ancient surface oceanographic conditions in the tropics and temperate regions. The geochemical compositions preserved in the coral skeleton are used to reconstruct the paleorecords, such as Sea Surface Temperature (SST), Sea Surface Salinity (SSS), winds and upwelling, ocean mixing, and river discharge histories. In this study, the fossil Faviidae coral sample (MYK90), collected near the western Miyako Islands located in the East China Sea (ECS), was analyzed in order to reconstruct the marine environment at 16 ka. As the sea level used to be significantly lower in this period, the fossil coral MYK90 is especially valuable because of much difficulty in sampling collection. The ECS is an important site for paleohydrological and paleoceanographic studies because it is under the influence of both coastal water and the Kuroshio Current. Coral skeletal $\delta^{18}\text{O}$ and Sr/Ca measurements were carried out and the application of Faviidae corals as a paleo-thermometer was explored. This is the first report that reconstructed the reliable SST and SSS in the glacial condition from a fossil Faviidae coral in the western Pacific. Also, the ocean environments in response to Asian Monsoon during the last glacial period are discussed.

Key words; Coral, Faviidae, Oxygen isotope, Sr/Ca, the Last Glacial Period, the East China Sea, SST, SSS

2. Study Site

The fossil Faviidae coral sample (Sample ID:MYK90) was collected at 24°43'N, 124°3'E off the Miyako Islands (Figure 1). Its age was 16.17 ± 0.52 ka (Sasaki *et al.*, 2006). MYK90 has columnar shape and belongs to family Faviidae. Clear annual bands can be obviously seen. A modern Faviidae coral (sample ID: CJK01) was collected at Chichijima, Ogasawara Islands for comparison.

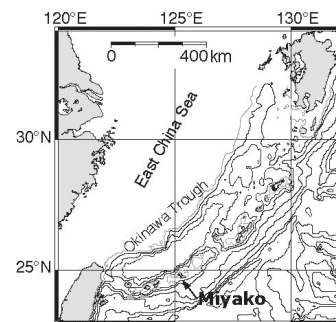


Fig.1 Study site.

3. Analytical Methods

3-1) Microsampling of fossil and modern Faviidae Microsampling for isotope and Sr/Ca analyses was conducted along the growth axis in the wall at an interval of 200 μm . 104 powdered subsamples were collected from MYK90. In the same procedure, 60 subsamples were taken from modern coral CJK01 for SST and SSS calibration.

3-2) $\delta^{18}\text{O}$, $\delta^{13}\text{C}$ and Sr/Ca measurement Isotopic (Oxygen and Carbon) and Sr/Ca analyses were carried out by an automated carbonate device (Multiprep, Micromass Co., Ltd.) coupled with a Micromass Optima mass spectrometer and an inductively coupled plasma atomic emission spectrophotometer (ICP-AES, IRIS Advantage, Thermo Electron Co., Ltd.), respectively, at the Geological Survey of Japan, AIST.

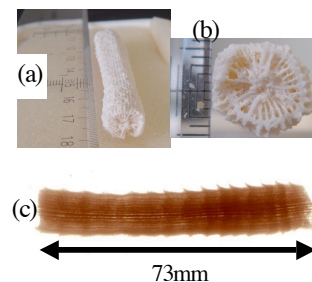


Fig. 2. Faviidae fossil coral MYK90 collected from the Miyako Islands. Photos of overview (a), cross-section (b), positive X-ray image (c).

4. Results and Discussion

4-1) Results The profile of the data obtained by $\delta^{18}\text{O}$, $\delta^{13}\text{C}$ and Sr/Ca Measurement are shown in Figure 3.

Fossil Faviidae coral MYK90 recorded paleo–environment at 16 ka with clear and regular seasonal fluctuation in its O and C isotopic and Sr/Ca data. Those values showed apparent shift toward cold and/or saline water condition. Besides, narrower amplitude of seasonal fluctuations compared to *Porites* corals was seen in both fossil and modern Faviidae corals. The small slope value for the SST dependence relationship can be attributed to the averaging effect in the growth of coral skeletons. Regardless of such an averaging effect, annual mean skeletal data of Faviidae are consistent with other genera corals (Suzuki et al., 2001). It was revealed that those data of Faviidae corals with annual or longer time resolution are perhaps highly applicable to paleoceanographic reconstruction.

4-2) Estimation of SST and SSS at 16 ka SST was calibrated by applying a default slope value -0.0600 mmol/mol $^{\circ}\text{C}^{-1}$ (Correge, 2006) to the gap of skeletal Sr/Ca data between fossil MYK90 and those of two modern corals collected from Ogasawara and Ishigaki. Those implications showed approximately 5.0°C and 5.2°C lower temperatures in the study site at 16 ka. SSS was calibrated by separating SST, ice sheet–derived SSS, and local SSS effects from allover gap of skeletal $\delta^{18}\text{O}$ between fossil MYK90 and modern coral collected from the Ishigaki Islands. SST effects were estimated by applying default slope value, $-0.022\text{‰}^{\circ}\text{C}^{-1}$. Followed by subtracting ice–sheet derived SSS effect from the entire ^{18}O value gap, it was concluded that the environment in the study site locally had higher SSS equivalent to at least 0.2‰ in $\delta^{18}\text{O}$.

4-3) Climatic implication Decrease in precipitation by summer monsoon and dry winter monsoon may be responsible for higher salinity than today (Xiang *et al.*, in press). It was also revealed that the area of the Miyako Islands had open–ocean type condition characterized by Kuroshio Current and influences of the terrestrial water discharge from main land China was not extended to this site around 16 ka.

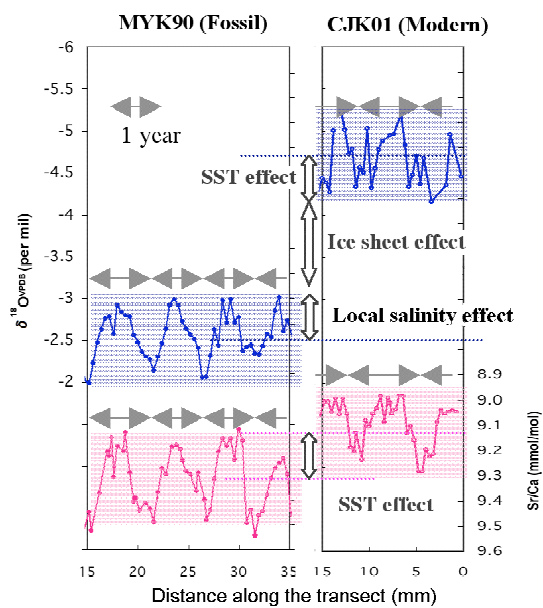


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