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論　文　内　容　要　旨

（NO．1）

氏　　名	熊谷　祐穂	提出年	平成 30 年
学位論文の題　　目	Characterizing Magnetic Mineral Assemblages of Calcareous Materials: Implications for Coral Magnetism and the Magnetostratigraphy of IODP Site U1490 （天然の石灰質物質が有する磁性鉱物の特性決定:サンゴの磁性や IODP の U1490 サイトの磁気極性層序への影響）		

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Paleomagnetism and rock magnetic properties of calcareous sediments and corals provide information about the environmental processes and conditions of when the sediments had deposited in addition to diagenetic history and settings. Coral skeleton (e.g., *Porites*) might have enormous potential as a high-resolution paleomagnetic recorder owing to their rapid and continuous growth over hundreds of years at a rate of up to 2 cm/year, although typical corals show an extremely weak

intensity of magnetic remanence and low stability. However, a measureable magnetization has been reported in deceased coral tsunami boulders along the shorelines of Ishigaki Island. It is necessary to determine the characterization of magnetic assemblages in coral skeleton to utilize them as a reliable paleomagnetic recorder, because paleomagnetic records are affected not only by past geomagnetic field variations but also by lithologic factors of samples, such as mineralogy, concentration and grain size of the magnetic phases, as well as directional alignment of magnetic minerals. Continuous records of geomagnetic field paleointensity variations from marine sediments not only allow constraint on geodynamo models, but they can also provide a way to correlate and date marine sediments globally. To enhance the feasibility for the geodynamo constraint and the isochronous correlation, we need to determine the concentration of magnetic minerals, magnetic particle grain size, and magnetic mineralogy of sediments, being changed by astronomically-driven climate cycles. In this study, I characterize magnetic mineral assemblages of corals in Ishigaki Island and of carbonate sediments from International Ocean Discovery Program (IODP) Site U1490 using petrologic observations by a field-emission type scanning electron microscope (FE-SEM), first order reversal curve (FORC) measurements and ferromagnetic remanence (FMR) measurements with acid treatment aiming to concentrate magnetic grains.

Combined analyses of a FORC diagram and FMR spectroscopy confirmed the presence of magnetosomes in the coralline boulders from Miyara Bay in Ishigaki Island before and after the acid treatment. The coral skeletons can envelope biogenic magnetite chains and protect them from direct exposure to acidizing process. It is also indicated that the main magnetic carriers of the *Porites sp.* coral colony on the Ibaruma coastline in the island are both magnetosomes and other magnetic minerals, the balance of which might vary dramatically from one part of the *Porites* coral skeleton to another. The coral skeleton in Ishigaki Island has the potential to provide a role as a new paleomagnetic recorder if some attention is paid to their origin of magnetic remanence.

The calcareous deep-sea sediment cores from IODP Site U1490 were measured in this study. Downcore profiles of FMR spectra and petrologic observations by FE-SEM showed the presence of biogenic magnetite chains and increasing Ti-bearing magnetic grains. They also divide the Hole U1490A into four parts, combined with magnetic susceptibility and rock magnetic parameters measured during Expedition 363, and mud wave migration observed in seismic profile. FMR spectra and rock magnetic characteristics of Hole U1490A possibly reflect the change of depositional environment. Comparing FMR spectra of acidized sediments with non-acidized ones, it is indicated that acid treatment for magnetic concentration can alter one of the FMR signals in the case of sediment samples. This is because the destruction of lipid bilayer membranes to envelop linear arrangement of magnetite (magnetosome), directly subjected to acid treatment.

FMR signals indicated that the deep-sea sediments recovered from IODP Site U1490 contain a different directional alignment of magnetosome chains. Because the biogenic magnetite chains make directional difference in magnetization efficiency in deep-sea sediments, attention should be paid to estimate relative paleointensity variations from the deep-sea sediments even its potential for establishing the long-term trend of the geomagnetic field strength.

別　紙

論文審査の結果の要旨

熊谷祐穂さんは，炭酸カルシウムから構成されるサンゴや深海底石灰質堆積物の残留磁気の起源を，強磁性共鳴の技術を用いて解明した。これまでに１編の研究論文を国際誌にて発表している。著者は国際深海科学掘削計画(IODP)の第３６３航海の乗船研究者として参加し、西部太平洋暖水塊(WPWP)における赤道域の過去９００万年～１９００万年にもおよぶ深海艇堆積物の掘削から船上での古地磁気測定、さらに乗船後の詳細な古地磁気測定をおこなっている。この博士論文では、主として強磁性共鳴(FMR)を用いて、この深海底石灰質堆積物中の磁性鉱物の起源や存在状態を研究したものと、石垣島のサンゴが有する磁性鉱物の起源を研究したものの２つから構成される。深海底堆積物コアで系統的なFMRの測定を行った例はほとんどなく新規性に富んでいる。解釈、議論にはまだ荒削りな点が少なくないものの、サンゴの残留磁化は主としてバクテリア起源のマグネタイトが担うこと、深海底石灰質堆積物で生物源・陸源磁性鉱物の割合の変動を捉えるのにFMRが有効であることを示すなどの成果が得られ、さらに、今後の発展の可能性として、バクテリア起源のマグネタイトの鎖状配列がサンゴや堆積物中でどう保存され堆積残留磁化とどう関係するかを解明していくためにFMRが大きなポテンシャルを持つことが示された。また、深海底堆積物の研究では、関連する膨大な古地磁気・岩石磁気データが得られていることが背後に覗える。膨大な量の深海底堆積物やサンゴ試料の古地磁気データを測定するばかりでなく、国際的プロジェクトの深海掘削船に乗船して世界各国の研究者と議論をし、試料採集から古地磁気測定、さらには過去の地磁気を復元するために必要なFMR等の基礎データにも目を向けて研究を進めてきている。これらのことは、博士に求められる高度な学識と自立して研究を遂行していく能力を備えていることを示している。従って、本論文は、博士（理学）の学位論文として合格と認める。