地磁気シールドは気候を変えるか？　スベンスマルク仮説の地質学的検証と新展開

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Does the geomagnetic field change climate? - Geological assessment of the Svensmark hypothesis

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The correlation between galactic cosmic ray flux and global cloud cover suggests that the cosmic rays may affect the Earth’s climate. Cosmic ray flux is strongly modulated by the geomagnetic field. During a geomagnetic polarity reversal, the decline of field intensity causes an increase of cosmic ray flux, which would result in increased cloud cover. This may cause climate change. This hypothesis, however, is not backed up by the robust geological evidence. In order to test this hypothesis, we examined this effect from the past two geomagnetic polarity reversals. These geomagnetic events are encompassed in interglacial periods and have periods of unusually weak geomagnetic field. The increased cloud impact on climate is most easily detectable at those times. We collected high-resolution climate, sea-level and paleomagnetic records using a sediment core from Osaka Bay, Japan. Comparing the global sea-level changes and the palynological warm proxy, the thermal maximum coincides with the sea-level highstand in Stages 17, 21 and 25. However, in Stages 19 and 31, the thermal maximum clearly lagged behind the sea-level peak, and the connection between orbital forcing and climate was disrupted. In these stages, there is a geomagnetic polarity reversal. The relatively cool phase is shown by the higher cool and lower warm palynological proxies. During the Matuyama-Brunhes polarity reversal, this phase coincide with the period during which geomagnetic field intensity was lower than 40% of its normal value and cosmic ray flux accordingly increased by more than 40%. The temperature decrease was about 3 deg. C based on the palynological data. The same cooling is also observed during the Lower Jaramillo reversal. Does this cooling effect affect the precipitation and/or East Asian monsoon system? In Japan, the temperature in summer is controlled by the temperature of Pacific air mass. On the other hand, the winter temperature is controlled by the Siberian air mass. The precipitations in summer and winter reflect the temperature gradient between the land and ocean in each season and hence are good indicators of summer and winter monsoon strengths. During the cooling events, annual temperature variability became larger and the summer precipitation decreased. If the cooling levels over land and sea are the same, then the temperature gradient would not change, either and hence the strength of the monsoon would never change. Cooler Japanese summers and winters, and a weaker summer monsoon could be caused by the temperature over land being lower than the temperature over the ocean. Then, the annual temperature variability becomes larger, and the summer monsoon becomes weaker. The cooling effect would be larger over the land than the sea. These evidence may suggest that the Earth’s climate can be affected by the geomagnetic field.