IODP proposal 612-Full2 for studying possibility of orbital modulation of the Earth's magnetic field

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The origin of the Earth's magnetic field is a fundamental problem in Earth and planetary sciences. The geodynamo has been thought to be a self-sustained system within the core, and maintained by heat and gravitational energies from the cooling Earth. Recently, however, external energy sources of the geodynamo, orbital forcing and/or paleoclimate changes, have been suggested from possible existence of the Milankovitch orbital frequencies in variations of geomagnetic-field strength (paleointensity) and direction (inclination) during the last ca. 2 m.y. recovered from marine sediments. We here propose a coring program to obtain long-term secular variation records of the geomagnetic field in both intensity and inclination back to ca. 10 Ma. The main purpose is to prove or disprove orbital modulation of the geomagnetic field, and to clarify energy sources of the geodynamo. There are two candidates for the cause of orbital modulation: the Earth's orbit itself and modulation caused by paleoclimatic (ice-volume) changes. These can be distinguished by investigating whether there is any change in the geomagnetic secular variations which corresponds to the major climatic events since late Miocene, for example, the mid-Pleistocene transition of glacial-interglacial cycles from the obliquity to eccentricity periodicities, and the onset of the northern hemisphere glaciation at 2.6 Ma. For recovering reliable paleomagnetic records, in particular those of relative paleointensity, it is required to use relatively oxic sediments with magnetic properties that are as homogeneous as possible. Considering expected penetration depths of about 200m for an Advanced Piston Corer (APC), sediments with moderate depositional rates of 10 to 40 m/m.y. are needed to obtain long-enough records with resolution of the orbital frequencies. A global distribution of sites is required for separating global and local geomagnetic features, for discriminating geomagnetic signals from artifacts controlled by lithological changes, and for testing a model of correlation between intensity and inclination variations. The requirement of global site distribution is incompatible with a conventional ODP-style leg, and hence we propose a multi-leg program to implement this kind of proposal; a few sites are devoted to this program during a leg mainly for other purposes carried out in a nearby area. To accomplish initial test of the hypotheses within a reasonably short period of time, we first focus on high priority sites in the three areas: the western equatorial Pacific, central North Pacific, and southeastern Pacific.