Magnetostratigraphy in the eastern Arctic Ocean, further palaeomagnetic results from Ymer-80 cores

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The reconstruction of palaeoceanographic events in the Canadian Arctic Ocean for the last 4.5 Ma is based on palaeomagnetic reversal stratigraphy of deep sea cores (Herman & Hopkins 1980). The interpretation of palaeomagnetic results in terms of genuine geomagnetic reversals results in sedimentation rates of the order of mm/ka, which is one order of magnitude less than corresponding accumulation rates for the eastern Arctic Ocean. The latter rate is founded on the interpretation of palaeomagnetic results from three cores north of Spitsbergen, which carry two zones with negative remanent inclinations confined within oxygen isotope stages 2–3 (Løvlie et al. 1986). The chronostratigraphic framework is based on C_{14}, amino acid and oxygen isotope stratigraphies, and the reversals are easily correlated with short duration excursions occurring around 30 and 60 ka, respectively. Since neither polarity chrons nor excursions appear to have unique directional signatures, reversed palaeomagnetic directions cannot be assigned to polarity chrons/subchrons without independent chronostratigraphic control.

Palaeomagnetic chronostratigraphy

Palaeomagnetic polarity stratigraphies may provide a chronostratigraphic framework by correlating with an established magnetopolarity time scale (MPTS). The most widely used MPTS is based on K/Ar dated lava flows with known palaeomagnetic polarities, and contain 23 reversals during the last 5 Ma (Mankinen & Dalrymple 1979). Only polarity chrons/subchrons with durations exceeding 40 ka are included, implying that this MPTS is not very useful for sediments younger than 700 ka. There is, however, mounting evidence for the existence of at least five short duration palaeomagnetic excursions within the Brunhes chron, three of which took place during the last 150 ka. The exact time and duration of these excursions have not yet been unambiguously determined, but records of anomalous palaeomagnetic directions consistently appear in a variety of sedimentary facies around 30, 50 and 110 ka, lasting some 3–5 ka. At present, it has not been conclusively shown that palaeomagnetic excursions are synchronous events of global extent.

Excursions confined within 20 to 60 ka have been encountered in three sedimentary cores from the northern slopes off Spitsbergen (Løvlie et al. 1986), implying that palaeomagnetic excursions may be potential chronostratigraphic markers within the region in question.

Palaeomagnetic results Ymer-80

Palaeomagnetic investigations of 16 sedimentary cores, raised north and east of Spitsbergen during the Ymer-80 expedition (Bostrøm & Thiede 1984), were performed on samples collected at 5–20 cm intervals, utilizing cubic plastic boxes (5.2 cc). The natural remanent magnetization (NRM) was determined on a Digico slow speed spinner (noise level: <0.2 mA/m). Progressive alternating field demagnetization to 60 mT in a two-axis tumbler reduced the NRM to between 15 and 2%.

Table 1. Palaeomagnetic mean directions of Ymer-80 cores (only positive inclinations).

		NRM			AF		
Core	N	Dec.	Inc.	α_{95}	Dec.	Inc.	α_{95}
107	30	076	81	9.8	040	76	11.5
108	5	340	80	27.4	008	75	27.7
109	4	211	64	11.6	210	64	13.9
110	19	219	83	14.3	333	74	17.4
120	19	280	71	11.5	290	73	10.8
122	22	258	76	8.8	262	79	11.7
123	18	283	70	6.6	282	83	7.1
125	31	269	29	10.6	189	58	19.2
126	13	297	73	10.8	281	68	11.7
130	47	287	63	4.9	274	55	5.7
137	20	135	89	8.5	119	85	6.0
138	25	245	66	5.6	240	68	6.9
139	19	264	56	6.9	280	75	6.6
141	23	027	81	12.0	249	87	13.3
144	17	319	80	12.2	360	83	10.1
147	35	296	71	8.6	299	75	9.7
					Mean	73° ± 9°	
Inclination of axial dipole field at 80°N						85° ± 11°	

Summary of palaeomagnetic results

Single component palaeomagnetic directions with median destructive fields (MDF) ranging between 10–40 mT dominate in all cores. Coarse grained matrix (sand) is often associated with palaeomagnetic unstable directions, although the palaeomagnetic record in general appears to be remarkably independent of lithology. Approximately half of the cores show pronounced effects of subsampling errors (Gravenor et al. 1984; Løvlie et al. 1986), reflected by directional distributions around 270° relative to the arbitrary geographic orientations of the cores (cf. Table 1). Hence, relative declinations do not yield reliable palaeomagnetic information. Inclinations have not been significantly affected by this effect, expressed by the general agreement between core mean inclinations and the expected value for the axial dipole field (ADF).

Shallow to reversed palaeomagnetic inclinations have been encountered in 10 cores, and may represent palaeomagnetic excursions. However, only one core (147 SGC) records zones of reversed directions defined by more than one sample. Tentatively, this core may have recorded excursions around 30 and 60 ka. Palaeomagnetic records in cores extending beyond oxygen isotope stage 5, inferred from calibration of calcareous nannofossil biostratigraphies (Gard 1986), do not carry reliable palaeomagnetic records of the two to three geomagnetic excursions inferred to have occurred during this period. Although depositional conditions (hiati, bioturbation) may readily explain the absence of palaeomagnetic excursions, the employed sampling intervals (mean 18 ± 8 cm) are likely to be too large in order to pick up records of short duration palaeomagnetic events (3–5 ka) in these cores, where the inferred average accumulation rates are 1–3 cm/ka. In comparison, the Polarsirkel cores, which recorded two excursions, were sampled at 2.7 ± 0.3 cm intervals.

Conclusion

The palaeomagnetic investigation of the 16 Ymer-80 sedimentary cores uncovered one possible excursion in core 147 SGC. The failure to detect further excursions is attributed to the employed inadequate sampling intervals.

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