

CORRESPONDENCE

The Editor,

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SIR, *On the lateral variation of the d.c. resistivity of sea ice*

In a recent review article by Schwarz and Weeks on the engineering properties of sea ice (Schwarz and Weeks, 1977), the authors refer to a series of geoelectric Schlumberger soundings which were made on first-year sea ice at Pond Inlet, N.W.T., in 1972 (as reported by Kohnen ([1976]) and also Thyssen and others (1974)). For these measurements, Schwarz and Weeks state that the sites for each of the Schlumberger profiles were specifically chosen for their apparent lateral homogeneity. This statement is incorrect and should be clarified. For these series of measurements, a set of markers were spaced at 1 km intervals across the ice sheet from the northern shore of Baffin Island to a southern point on Bylot Island. The Schlumberger soundings were performed by V. M. Cowan and myself at each of the 22 markers in three separate traverses across the ice sheet (16–19 May, 3–6 June, 15–21 June), and each of the actual sites for the soundings were chosen simply to be as close as possible to these markers. Since several of the markers were placed in irregular, ridged ice, it was not always possible to perform the Schlumberger profile on open, laterally homogeneous ice. In fact, no specific attempt was made to do this on these traverses. Thus, in some cases the soundings were performed in, or just beside, rafted ice with ridges *c.* 0.5–1 m high. Therefore the ice sampled at each station was not necessarily laterally homogeneous and smooth as indicated by Schwarz and Weeks. The results of these experiments showed fluctuations in apparent resistivity values by a factor of four (Kohnen, [1976]). This variation reflects the combined influences of the microstructure, macrostructure, and brine volume on the electrical resistivity of sea ice.

In a series of soundings completely separate from the three traverses discussed above, Schlumberger profiles were performed on laterally homogeneous ice specifically to check the consistency of the resistivity and values of apparent ice thickness over a relatively homogeneous portion of the Pond Inlet ice. This

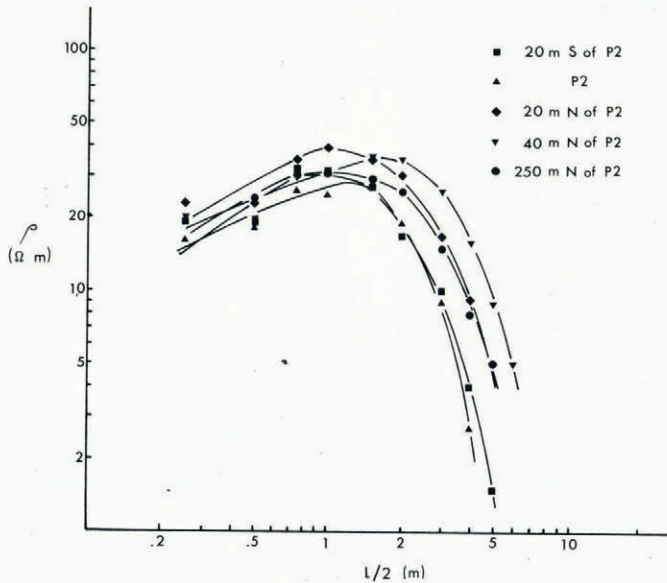


Fig. 1. Log-log plot of the electrical resistivity ρ as a function of one-half the current electrode spacing L for five Schlumberger soundings performed on laterally homogeneous ice at Pond Inlet, N.W.T. (15 June 1972).

series of five Schlumberger soundings was performed on 15 June 1972 (i.e. just prior to the third traverse), approximately 1 km from the north shore of Baffin Island at the first ice marker station (station P2, Thyssen and others, 1974; Kohnen, [1976], 1976). The results of these soundings are presented in Figure 1. This shows a log-log plot of the measured Schlumberger resistivity ρ as a function of one-half the current electrode spacing L at each of the five measuring sites. Treating this situation as a three-layer case (i.e. a two-layer model for ice of upper resistivity ρ_1 and lower resistivity ρ_2 and total apparent ice thickness h_1 over an infinite body of water (see Kohnen [1976])), the ρ_1 , ρ_2 , and h_1 values determined using the data in Figure 1 are listed in Table I. Clearly, in this special case of warm, laterally smooth ice, the resistivity values were reasonably consistent. With respect to the ice thickness data, the apparent ice thickness was consistently less than the measured ice thickness ($h = 1.8$ m at P2, Kohnen, [1976]).

TABLE I. TEST RESULTS FOR SCHLUMBERGER SOUNDINGS ON FIRST-YEAR SEA ICE AT POND INLET, N.W.T. (15 JUNE 1972)

Position	Upper layer resistivity	Lower layer resistivity	Apparent ice thickness
	ρ_1 Ω m	ρ_2 Ω m	h_1 m
20 m south of P2	11	55	1.0
P2	12	36	1.1
20 m north of P2	14	56	1.1
40 m north of P2	13	39	1.7
250 m north of P2	13	52	1.1

However, it can be shown that in an anisotropic medium such as sea ice, the apparent thickness h_1 is related to the true thickness h by $h_1 = \lambda h$ where λ is the coefficient of anisotropy (see, e.g. Bhattacharya and Patra, 1968). At station P2, $h_1 = 1.1$ m and $h = 1.8$ m so that $\lambda = 0.61$. This is in good agreement with the value for λ of 0.59 determined for this ice using only the measured resistivity values (Timco, 1979). Clearly, these results suggest that under some circumstances and over moderate distances within an individual ice sheet, the results of Schlumberger or geoelectric soundings can be reasonably self-consistent. However, as pointed out by Schwarz and Weeks, in most cases the results obtained from these types of measurements are quite variable due to the complex interrelation of the factors affecting the electrical resistivity of the ice. Certainly, much more experimental work is required in this area before it will be possible to determine quantitatively the relative importance of the factors influencing the resistivity results.

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