The Perturbation of Alternating Geomagnetic Fields by an Island Near a Coastline: Reply

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The discussion by Nyland (1973) of our recent paper (Lines and Jones 1973) gives a good description of surface charge behavior in terms of the usual boundary conditions as described in Stratton (1941). The argument that Nyland uses is essentially the one used by Lines and Jones (1973) and previously by Lahiri and Price (1939). We agree with his general arguments and conclusions, though we feel several points should be made.

We feel that Nyland's sentence "Their emphasis on displacement currents is an unjustified complication" is somewhat misleading. On page 513 of our paper we stated that displacement currents have been neglected, and the conditions under which this is done. Furthermore, in previous discussions on this same question, Price and Jones (1972) and Price (1972)[1] have shown that the currents arising from the surface charges are *not* displacement currents.

Nyland points out that the approach taken by him is more general than our discussion. The discussion in our paper was concerned with the limiting case where $\sigma = 0$ on one side of the boundary, whereas the condition taken by him is that $\sigma_1 << \sigma_s$. Our equations are identical to those of Nyland when one considers that we have taken the case $\sigma_1 = 0$ and have used a time variation $\exp(i\omega t)$ and emu. For example, his expression for $E_{n1}(\simeq\beta/\epsilon)$ is our seventh equation $(\beta \simeq -(\epsilon'/4\pi)\, E_z')$.

In our paper we have estimated the magnitude of the surface charge as did Lahiri and Price (1939) and have shown that the normal component of the electric field just inside the conductor is negligible when compared to the normal component of the electric field just outside the surface. The minute time-varying surface charge causes a non-zero electric field outside the conductor and reduces the vertical component of the electric field just inside the conductor to a negligible value, so that currents just inside the conductor essentially flow parallel to the surface. We wish to point out again that Price (1967, and elsewhere) emphasized that although the electric field of the varying surface charge distribution is important, the magnetic field of the associated current flow is negligible.

[1]Price, A. T. 1972. The theory of geomagnetic induction. Review paper given at the Workshop on Electromagnetic Induction, Edinburgh, September, 1972. To be included in proceedings to be published in Phys. Earth Planet. Int.

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