# 6 Ground conductivity

## 6.1 The conductivity of land

For initial planning and for compatibility or frequency re-use assessments, the information in Recommendation ITU-R P.368, and its corresponding procedure in GRWAVE, is well established and widely used. However, the biggest uncertainty is likely to be in the estimation of the ground constants, and in particular of the ground conductivity. The electrical characteristics of the surface of the earth are discussed in Recommendation ITU-R P.527. It may be noted that the characteristics are expected to be independent of frequency at HF and lower frequencies (apart from the case of fresh water ice at LF and VLF).

However it is important to note the expected penetration depth, or skin depth, of radio waves into the ground[[1]](#footnote-1)\*. For sea water the penetration depth (the depth at which signals are attenuated to 1/e of the surface value) is only about 25 cm at 1 MHz. But for medium dry ground it is about 25 m. Thus in determining or estimating the effective conductivity for use in predicting the coverage at MF, and even more at LF, it will be important to take proper account of the sub-surface geology.

Methods of determining the conductivity by using earth probes or other methods of measuring a soil sample are very unlikely to give useful results, since they will usually measure only the characteristics of the top soil. The most valid measurements would be made using test or operational transmitters and making a series of measurements at various distances, see section 19.3.

Recommendation ITU-R P.832 provides conductivity maps for both VLF and for MF. The VLF maps are for continental areas and extend over almost all of the land areas of the world. The MF maps are for many individual countries, or groups of countries, as provided by administrations. Opinion ITU-R 91-1 expresses the opinion that administrations should check and, if necessary, revise the information given in the World Atlas, noting that in some cases seasonal changes may need to be included; that new administrations should check that their needs are covered in the current World Atlas of Ground Conductivities and contribute to revisions of the data; and that for those countries for which no conductivity data are contained in the World Atlas, the administrations concerned should collect and provide data in accordance with the information given in Recommendation ITU-R P.832.

1. \* The skin depth in an arbitrary material is given by:

  (20)

where:

δ is the skin depth, ω=2πf, σ is the conductivity, μ0 is the permeability of free space, μr is the relative permeability, ε0 is the permittivity of free space, εr is the relative permittivity, [↑](#footnote-ref-1)