leaves for CMV indexing, samples that oxidize despite the presence of reducing agents can produce false positive reactions in ELISA[11]. These reactions can be minimized by thorough washing of the mucilagenous antigen samples from the wells of the plate before adding the next reagent.

Even though there is no significant difference in the sensitivity levels of virus detection with three tests, the reagents and time required to carry are varied. DAC-ELISA is economic, requires about 5–6 h and is more versatile as the test can be automated and commercialized for application to crops like banana.

In laboratories with minimal facilities, more glasshouse and time (3–4 days) are not the criteria, detection of CMV in banana by bioassay on local lesion hosts like cowpea or green gram (*Phaseolus aureus*) appears suitable routine practice. Further, the other four viruses known to infect banana did not infect these local lesion hosts and thus bioassay is useful for distinguishing CMV from other viruses of banana.

The dsRNA analysis has been used as one of the criteria for identifying the various isolates of CMV in Australia[12]. The application of this technique requires more time (2–3 days), expertise and expensive laboratory facilities. Moreover it is suitable for detecting the virus in a small number of samples. The samples that were positive by DAC-ELISA are also positive by the other two tests (Table 2). Finally we conclude that DAC-ELISA is a suitable test for routine application in large-scale testing of banana encountered in plant quarantine, in planting material (suckers) certification programmes and in banana field surveys.

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Thin layer problem in geoelectrics

I. B. Ramaprasada Rao, Ram Raj Mathur and S. Srinivas

Centre of Exploration Geophysics, Osmania University,
Hyderabad 500 007, India

Inferences in the influence of a thin conductive layer on the controlled source audiofrequency magnetotelluric (CSAMT) Cagniard response as compared to magnetotelluric (MT) soundings are studied. For this purpose, H_r and E_ϕ components are computed due to a horizontal electric dipole (HED) over a layered media without imposing farfield or nearfield conditions for the CSAMT method. The computation is carried out in a cylindrical coordinate system using Hankel transform of Bessel functions of order zero and unity with a 100 point digital filter.

The root mean square (RMS) deviations between the CSAMT response with and without thin conductive layer, in the frequency ranges of 0.125 Hz to 4096 Hz are computed. A similar scheme of computation is implemented for the MT response. This difference is uniformly higher for the CSAMT within the range of parameters investigated and hence the CSAMT method is preferable over the MT method for delineation of the thin intermediate conductive layer. Conversely, if a lesser influence of the thin conductive layer is desired, MT soundings are preferred over CSAMT studies.

THE influence of a thin conductive layer has been studied in electromagnetic prospecting by several authors[1-15]. Molochnov[16] studied the influence of a thin conducting layer on the field components of a vertical magnetic dipole (VMD) source in terms of tabulated functions so that the maximum effect can be computed for any chosen frequency. The present study is aimed at assessing the influence of thin conductive layer on CSAMT Cagniard response as compared to MT. This study acquires added significance in view of the presence of conductive thin layers (red bole) and intra- and infratrappean sedimentary sequences in the vast Deccan flood basalt region which is coming into sharp focus for two reasons, namely, neotectonic activity and energy resource potential of the lithounits below the Deccan trap covered terrain.

The components of the electromagnetic field on the surface of a multilayered earth for a horizontal electric dipole (HED) are available in literature[17]. Over a multilayered earth for far field conditions ($|kr| >> 1$ where k is the wave number given by $k = \sqrt{i\sigma\mu\omega}$), the apparent resistivity can be obtained as

$$\rho_a = \frac{1}{\omega\mu}|Z_n|^2, \quad (1)$$

where Z_n is the ratio of electric and magnetic field components.

The apparent resistivity for the MT method over a multilayered earth[18] can be obtained through equation (1), where the impedance Z_n is given by

$$Z_n = \frac{\omega\mu}{k_1}\coth h\left\{-ik_1h_1+\coth h^{-1}\left[\frac{k_1}{k_2}\coth h\left(-ik_2h_2 +\coth h^{-1}\left\{\frac{k_2}{k_3}\coth h\left[-ik_3h_3+\ldots+\coth h^{-1}\left(\frac{k_{n-2}}{k_{n-1}}\coth h \left\{-ik_{n-1}h_{n-1}+\coth h^{-1}\frac{k_{n-1}}{k_n}\right\}\right)\ldots\right]\right\}\right)\right]\right\}. \quad (2)$$

Thus, in the far field conditions, the CSAMT apparent resistivity fully coincides with the MT Cagniard resistivity. However, a marked difference exists when the condition of $|kr| >> 1$ is not valid[19-21].

We computed two categories of Cagniard CSAMT responses as a function of frequency using the corresponding equations (expressions 2.191, 2.209 and 2.210) (ref. 17) for a multilayered earth in order to investigate the effect of a thin conductive layer on the CSAMT response. Category I corresponds to two-layer geoelectric model for different ρ_2/ρ_1 and r/h_1 values, where r is the transmitter receiver separation and ρ_1, ρ_2 and h_1 are the resistivities of the first and second layers and the thickness of the top layer respectively. Category II corresponds to geoelectric models with a thin layer of constant thickness (1 m and 2 m) and resistivities (0.04 ohm m) with varying depth of burial introduced into the two-layer system (chosen in Category I). The details of these models are given in Figure 1. The MT response curves were computed using equations (1) and (2) for the same geoelectrical models.

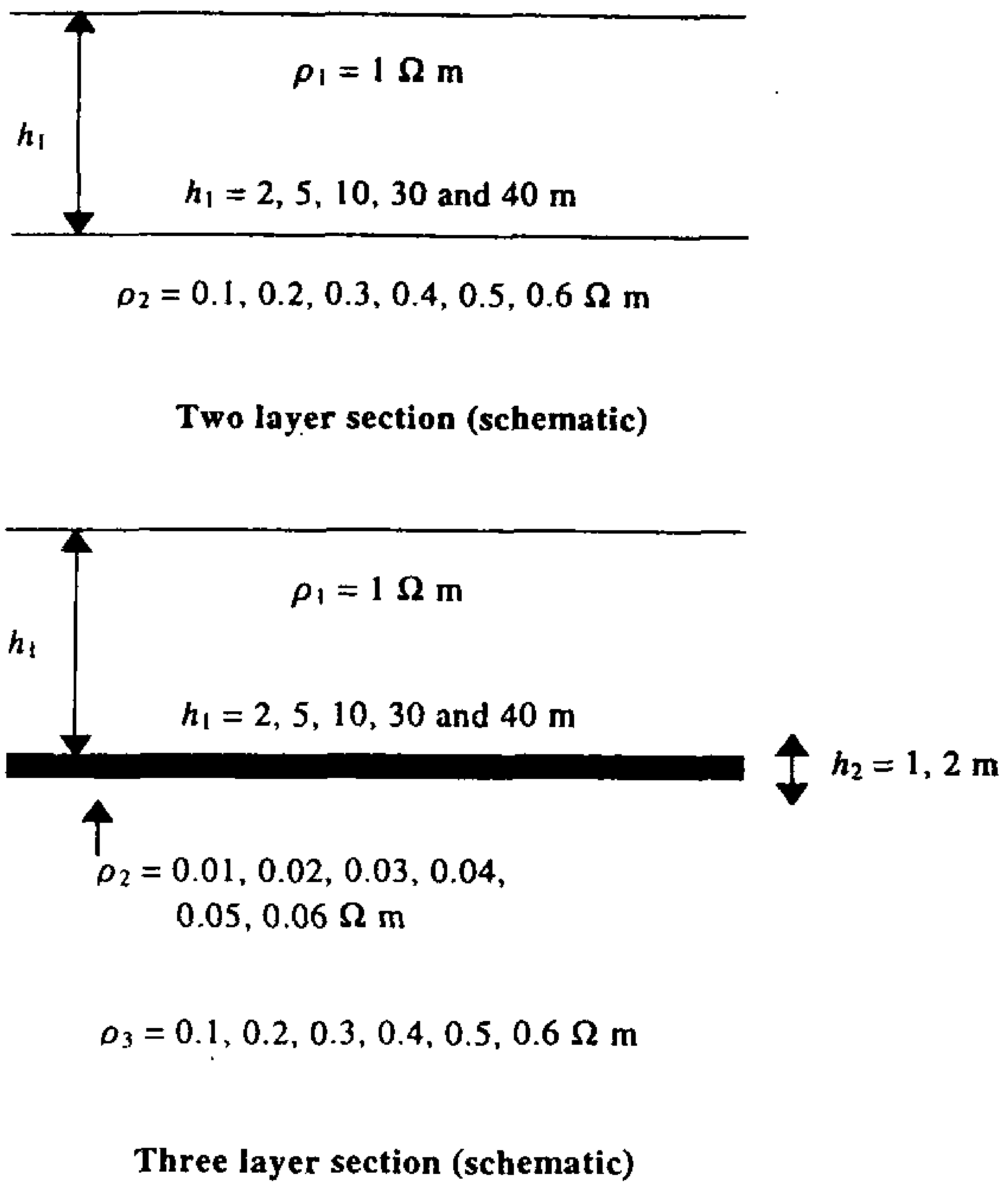

Figure 1. Geoelectrical models.

The scheme of computation developed for this purpose first computes the H_r and E_ϕ components due to a HED source over layered media without imposing either the farfield or the nearfield conditions and then computes the Cagniard resistivities and RMS difference[22] between CSAMT response curves with and without the thin layer, in the entire measurement range of frequencies. The electromagnetic field of HED was computed in a cylindrical coordinate system using Hankel transforms of Bessel functions of order zero and unity with a 100 point digital filter[23].

A similar computational scheme implements the procedure for MT response.

Figures 2 and 3 show examples of four pairs of response curves for the CSAMT and MT respectively. The solid curves a, c, e and g in Figure 2 are two layer cases with resistivities $\rho_1 = 1.0$ ohm m and $\rho_2 = 0.66$ ohm m and $h_1 = 2$, 5, 10 and 20 m in this order (category I). The broken curves (b, d, f and h) shown in Figure 2 involve a thin conducting layer of resistivity 0.04 ohm m and thickness 1 m at depths 2, 5, 10 and 20 m in this order (category II). A similar representation has been used for the MT responses in Figure 3.

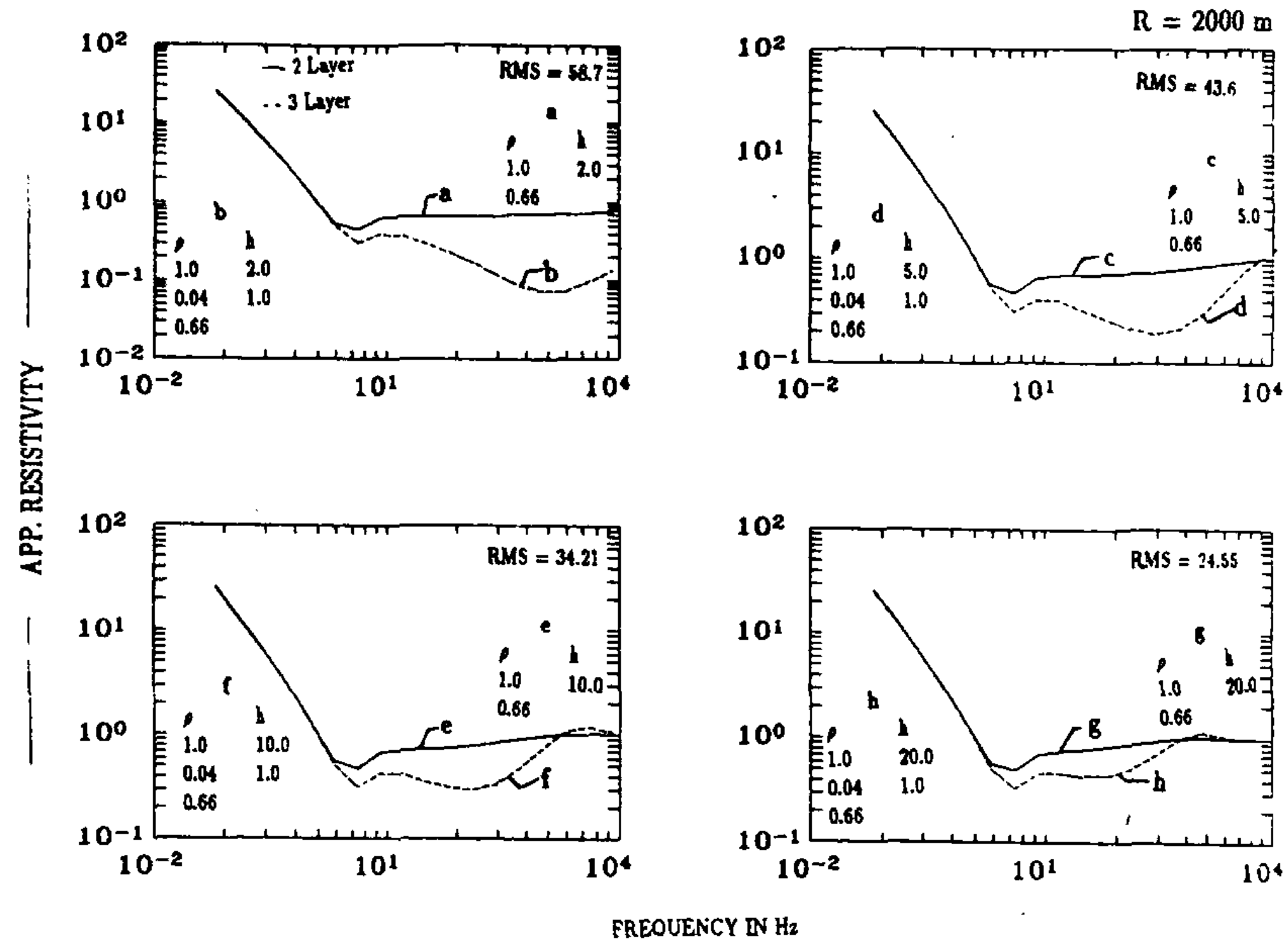

Figure 2. CSAMT response without and with the thin conductive layer.

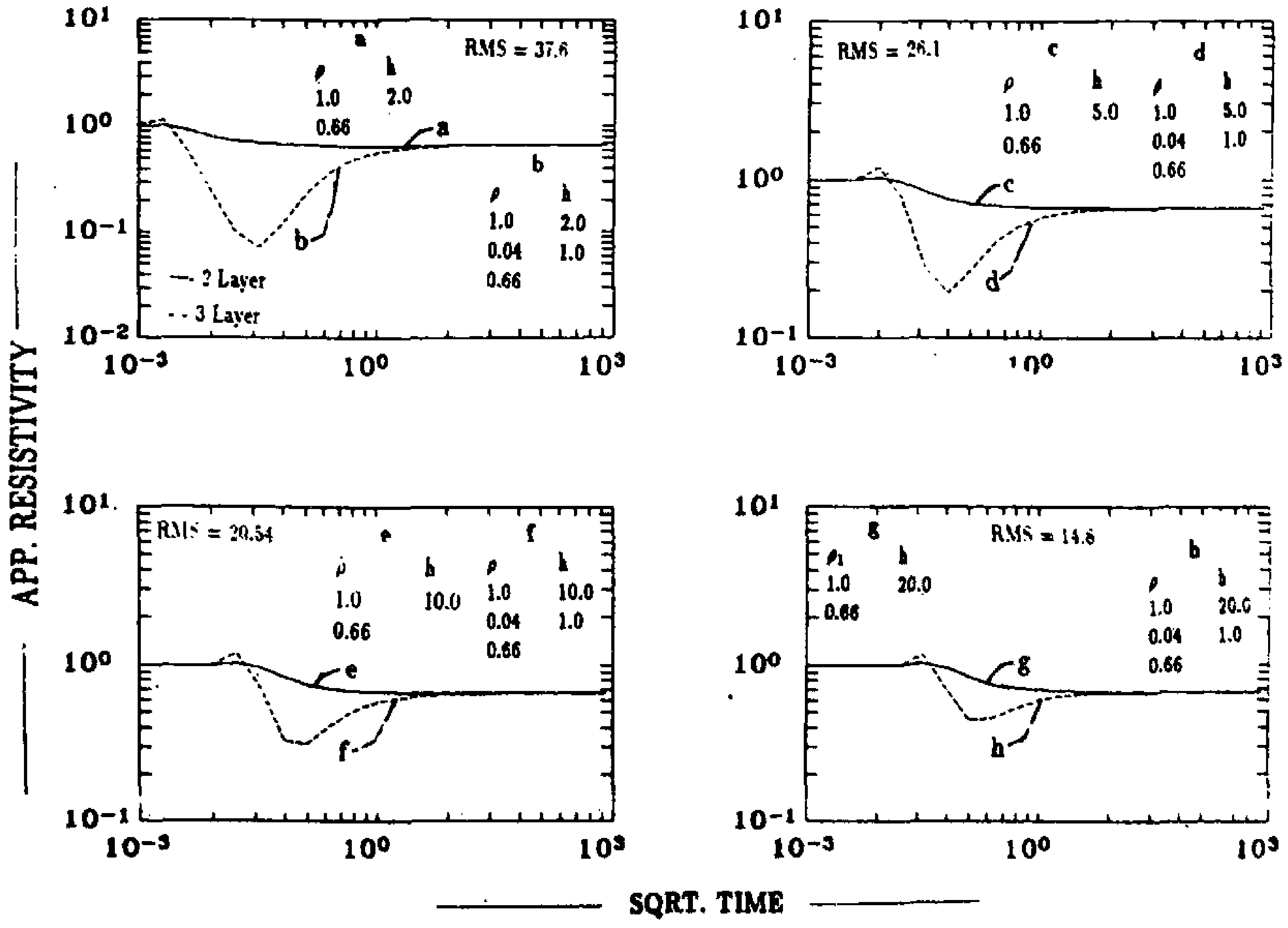

Figure 3. MT response without and with the thin conductive layer.

The normalized non-dimensional presentation allows one to understand the effects for multitude of geoelectric truths from the response functions thus computed.

We can note (from Figure 2), as is expected, that the RMS difference between the CSAMT response with and without the conducting layer progressively diminishes as the depth to the thin conductive layer increases.

The relationship of RMS difference with h_2/h_1 for various ρ_2/ρ_1 ratios for a particular ρ_3/ρ_1 value in the CSAMT and MT is shown in Figures 4 and 5 respec-

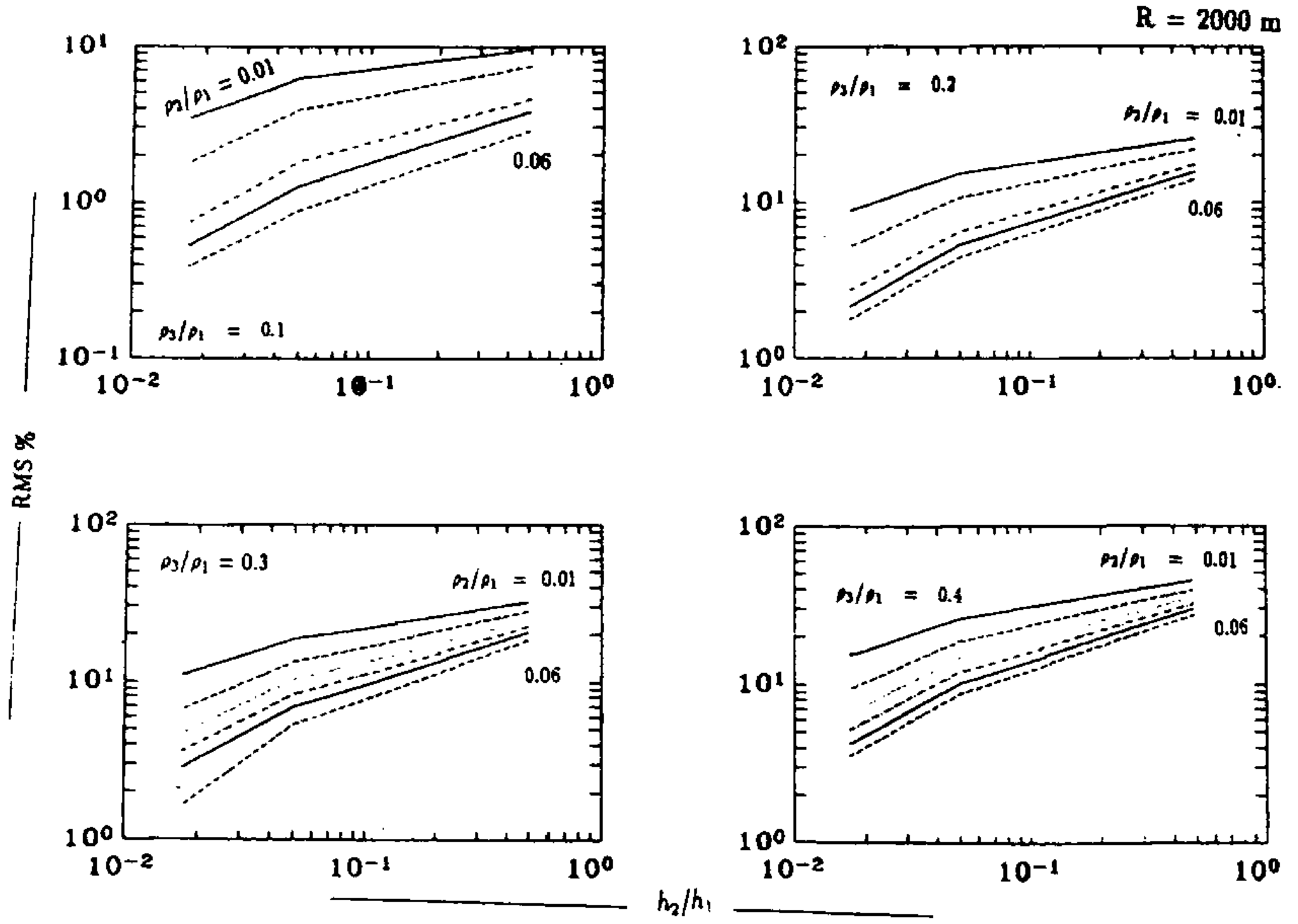

Figure 4. Relationship between h_2/h_1 and RMS error % for CSAMT data.

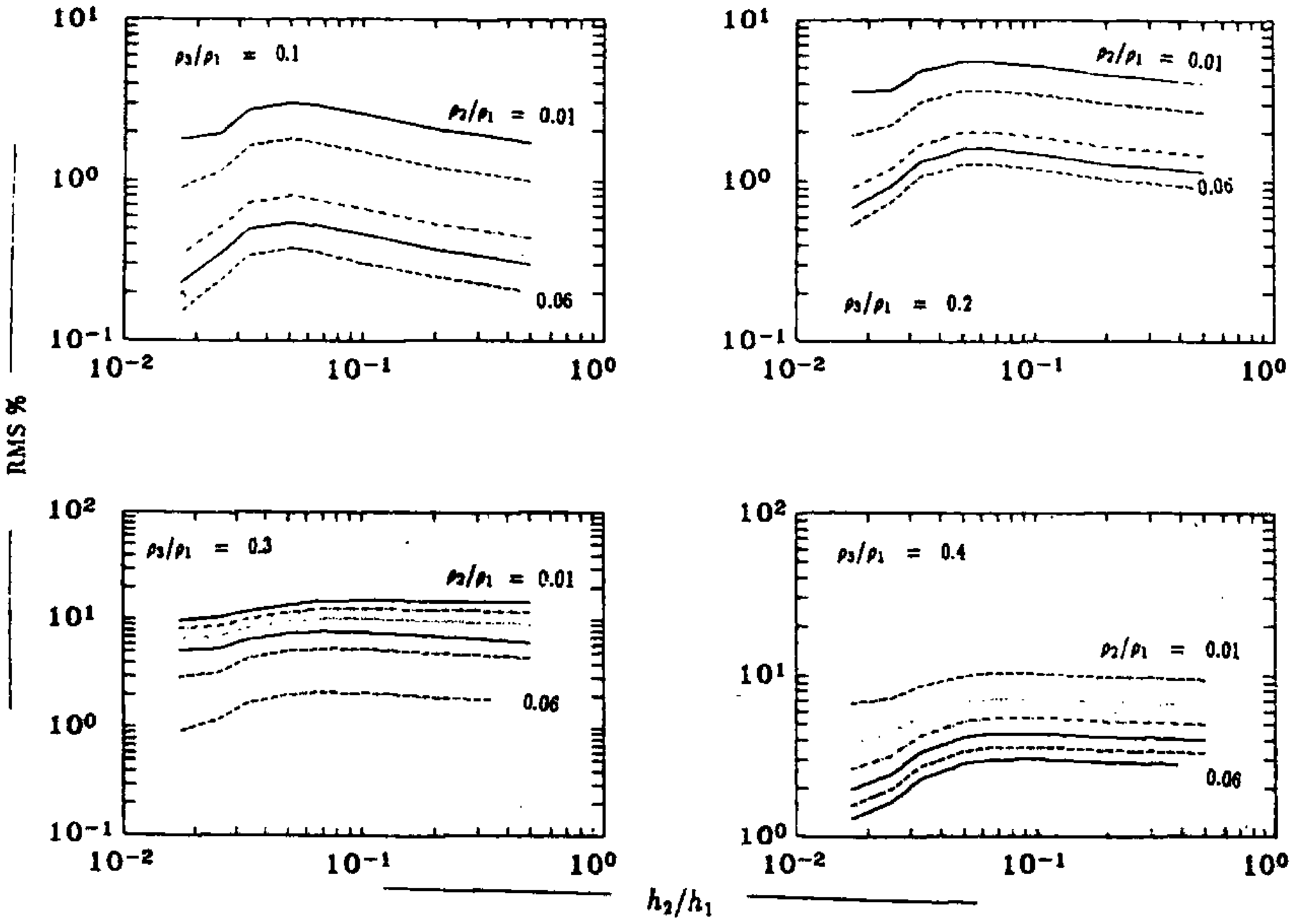

Figure 5. Relationship between h_2/h_1 and RMS error % for MT data.

tively. We thus obtained the combination of h_2/h_1, ρ_2/ρ_1 and ρ_3/ρ_1 for any chosen RMS value.

Figure 6 shows a comparison of the RMS deviation in percent for different thickness ratios in the CSAMT and MT techniques. The RMS deviation is consistently higher for the CSAMT technique (compared to MT) within the range of parameters investigated and hence the delineation of the thin conducting layer as a separate entity is better in CSAMT when compared to MT. However, in case lesser influence of the intermediate con-

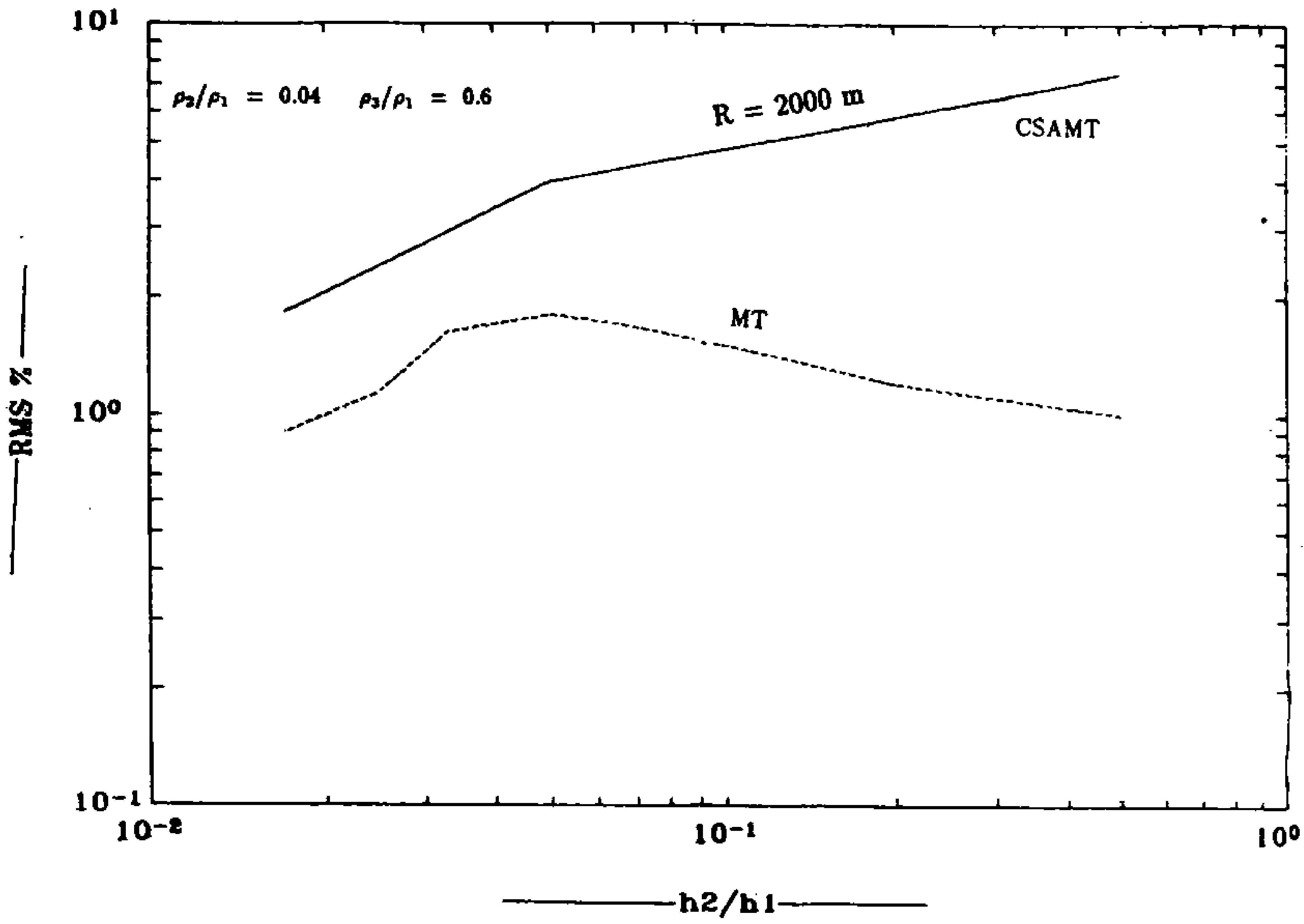

Figure 6. Comparison of RMS error in CSAMT and MT.

ducting layer is desired, MT soundings are preferable over CSAMT studies. In general, it appears that the influence of a thin conductive layer increases, with an increasing h_2/h_1 for given resistivity contrast in the CSAMT. On the other hand it is interesting to observe that a sort of a 'tuning effect' with respective h_2/h_1 is seen in the MT technique for certain resistivity contrasts, which implies that within a range of h_2/h_1 (0.03 to 0.05 in Figure 6) the influence of thin conductive layer is prominent in the MT technique. However, this tuning effect depends on the resistivity contrast also. For large values of h_2/h_1, the CSAMT sounding appears to be more suitable than the MT technique, when the study is aimed at detecting the intermediate conductive layer.

Thus, it is desirable to explore the potential of the CSAMT technique for the effective detection of sedimentary units intermediate conductive layers (intratrappeans, redbole vesicular trap horizons, weak zones, etc.) in the Deccan trap regions of the country.

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