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Geophysical Delineation of Surface Trace of the Main Boundary Thrust, near Taxila

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ABSTRACT

Main boundary thrust is the major tectonic feature in the north of Islamabad/Rawalpindi and crosses G.T. road near Nicholson Monument. Along this fault the Margala Hill limestone is thrusted over the sandstone of Murree Formation. For searching the location of the surface trace of the fault which is buried under the alluvium, electrical resistivity technique was applied using Wenner and Schlumberger configurations. The interpretation of vertical and horizontal resistivity profiling along G.T. road on both sides of Nicholson Monument, suggests that the surface trace of the fault may be about 590 meters south of Nicholson Monument.

INTRODUCTION

Main Boundary Thrust (MBT) is the southern front of Himalaya and displays one of the major and youngest lineament on which the pre-collisional pre-Cambrian and Paleozoic rocks are thrust over the Murree Formation of mid-Oligocene to Miocene age (Yeats and Lawrence, 1984). It is a shallow thrust and dips less than 15 degrees to the north, and is involved in Hazara-Kashmir syntaxial bend and extends westward (Figure 1) in the hill ranges of southern Hazara, Murree, Margala, Kalachitta, Attock-Cherat, Kohat and then into Afghanistan (Tahir Kheli, 1984).

Between Murree and Islamabad it swings southwest and west and crosses G.T. Road (Rawalpindi - Peshawar line) at Nicholson Monument (N.M) near Taxila where drastic change in lithology is apparent, that Margala Hill limestone is thrusted over the sandstone of Murree Formation. At that location this contact is buried under the alluvium and our objective was to find out the surface trace of the fault. Since the physical properties such as resistivity, density and susceptibility of limestone are different from those of sandstone (Ali and Mujtaba, 1992), the contrast in physical properties provide basis to use geophysical approach (Khan and Ali, 1994). For this purpose we used resistivity (Schlumberger and Wenner configurations) technique along G.T. Road between Coca Cola Factory and Taxila (Figure 2) as its applicapability for delineating faults and formational contacts has been suggested by Verma (1982) and theoretical suitability and effectiveness is proved by Huber (1955) and Maeda (1951,1955).

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VERTICAL RESISTIVITY PROFILING (SCHLUMBERGER)

Vertical resistivity profiling with the use of Schlumberger configuration is equivalent to vertical logging as it reveals lithologic changes as a function of depth, and conducted with a maximum spread of 400 meters at four sites; three of which are located south of Nicholson Monument and one is situated north of that.

The first vertical resistivity profile was carried out near Tamul Restaurant at a distance of 13 Km south of Nicholson Monument (N.M). The interpreted results showed the presence of 80 meters thick alluvial cover (gravely clay and clay) over deep extending sandstone (Figure 3a).

The second probing done at a distance of 1.4 Km south of N.M. along G.T. Road showed gravely clay upto a depth of 25 m, below which low resistivity shale or clay extends upto a depth of 200 meters (Figure 3b). Third profile carried out at a distance of 300 m south of N.M. indicates the presence of highly resistive limestone at a depth of 25 meters (Figure 3c). But in the fourth profile which is 1.5 Km north of N.M. towards Taxila, the limestone appears to lie at 60 meters depth (Figure 3d).

From these results it is obvious that the sandstone encountered at a depth of 80 m at Tamul Restaurant is being deepened more than 200 meters towards north, and near Nicholson Monument (300 meters south of it) limestone gives its appearance at a depth of 25 meters and is deepened to 60 meters depth within a distance of 1.5 Km north of N.M. Thus, it implies that the strata is dipping towards north and the area about 300 meters south of Nicholson Monument is probably the fault zone where limestone is thrusted over. This zone shows a drastic change in resistivity corresponding to a change from sandstone to limestone.

HORIZONTAL RESISTIVITY PROFILING (WENNER)

To be more precise about the location of surface trace of the fault the horizontal resistivity profiling with Wenner configuration of 180 meters spread (a=60 meters) was carried out between 1380 m to 300 m south of Nicholson Monument. Prediction of lateral variation of lithology within a specified depth was concerned mainly with theoretical expectation of the generation of resistivity peak at a distance of a/2 from the fault trace (Figure 4a). The resistivity curve obtained along this profile accordingly shows a peak at a distance of 540 m south of Nicholson Monument (Figure 4b) suggesting the probable site of surface trace of the fault at a distance a/2 further south of that, i.e., 570 meters.

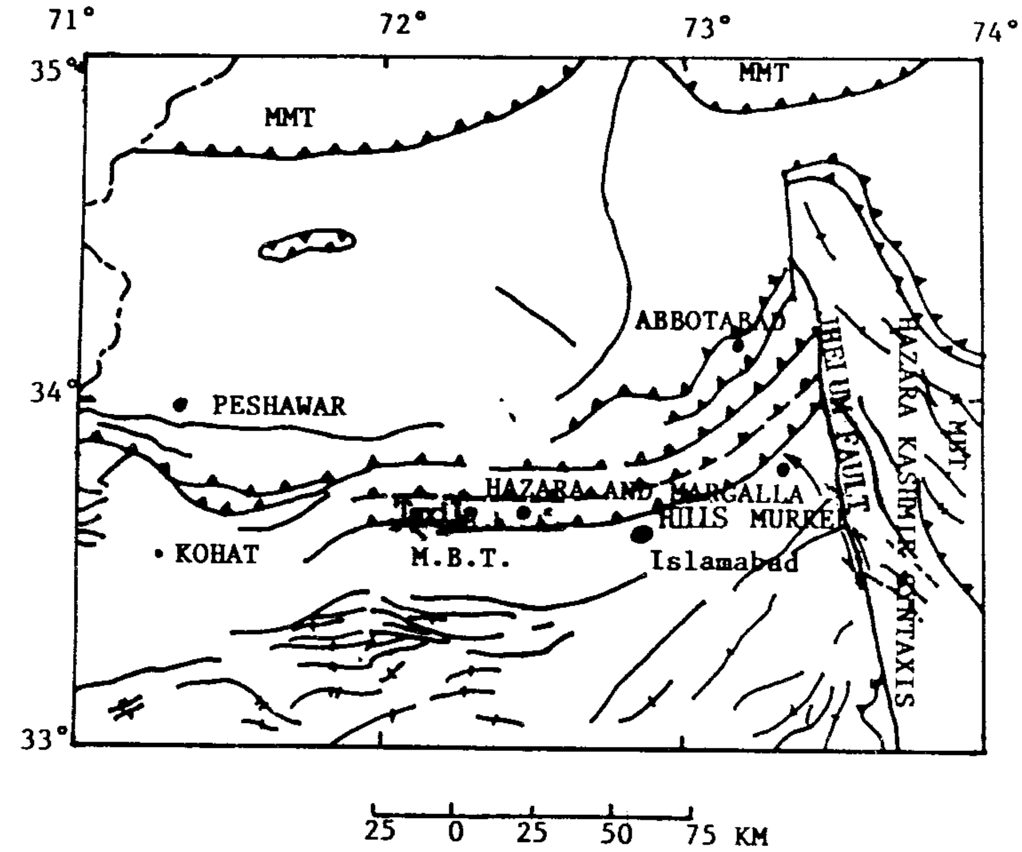

Figure 1-Tectonic map of northern Pakistan showing Hazara-Margala Hills, Main Boundary Thrust (MBT), and Hazara-Kashmir Syntaxis

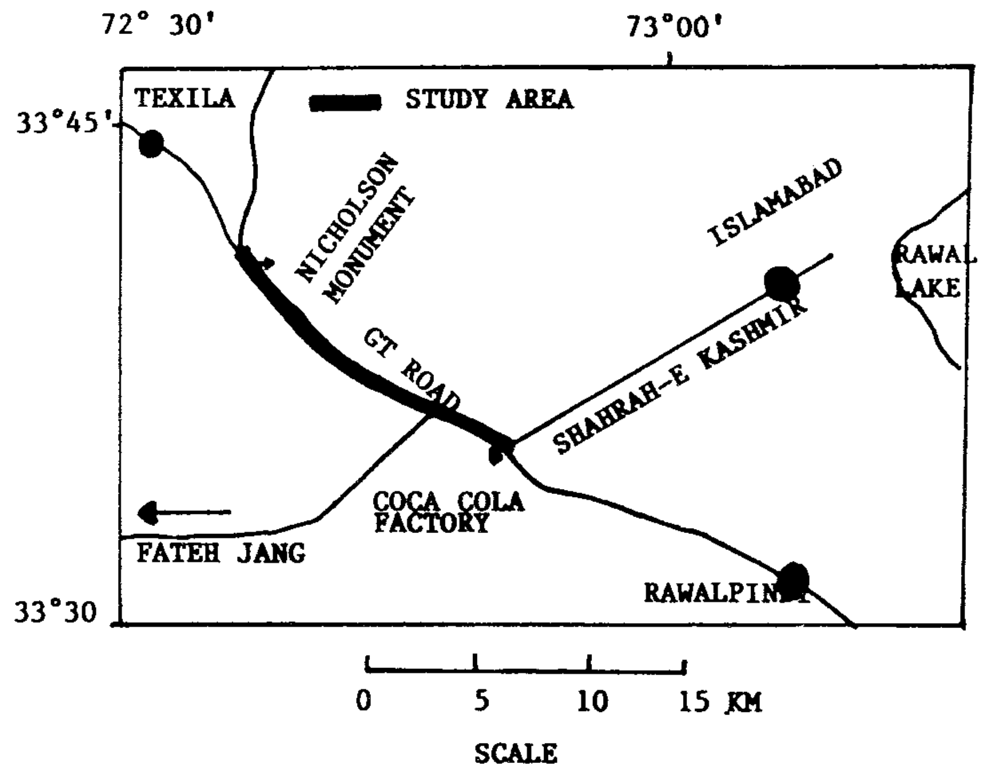

Figure 2-Location map of the study area.

VERTICAL RESISTIVITY PROFILING (WENNER)

Huber (1955) and Maeda (1951) describe theoretically that vertical resistivity profiling with Wenner configuration along a traverse perpendicular to the strike of the fault shows for a station one unit to the left of the outcrop of a fault, over the medium of higher resistivity, an abrupt decrease in the apparent resistivity as the current electrode C crosses the fault plane. The minima of the curve, however, occurs as C lies a short distance to the right of the outcrop of the fault trace. As the potential electrode P crosses the contact a high peak occurs. For a station one unit to the right of the outcrop of the fault trace, that is over the medium of lower resistivity, a current converging peak occurs as C crosses the outcrop of the fault and a discontinuity in slope occurs when P crosses the contact (Figure 5a). Following Huber and Maeda we carried out three vertical resistivity profiles using Wenner configuration at distances 540 m, 640 m and 740 m south of Nicholson Monument. The first vertical resistivity profile centered at a distance of 540 m south of N.M. showed rising trend in resistivity curve without any abrupt change and suggested high resistivity material underneath. The second profile centered at a distance of 740 meters south of N.M. contrarily gave declining trend without any abrupt change, and suggested low resistivity material underneath.

The third one centered at a distance of 640 meters south of N.M. showed a peak when the current electrode C crossed the contact and a discontinuity in slope appeared when potential electrode P crossed it (Figure 5b). Thus, the last profile appears to dictate the conditions of Huber (1955) and Maeda (1951), and suggests that the contact of the fault possibly is lying roughly 30 meters north of this center, i.e. 610 meters south of Nicholson Monument.

CONCLUSION

Horizontal and vertical resistivity profiling provide almost similar estimates i.e., 570 m or 610 m as the probable distance of the surface trace of the fault. The deviation in results is minor and may be due to the difference of profiling mode, however, for adjustment we take the average and infer that the surface trace of the fault could be 590± 20 meters south of Nicholson Monument.

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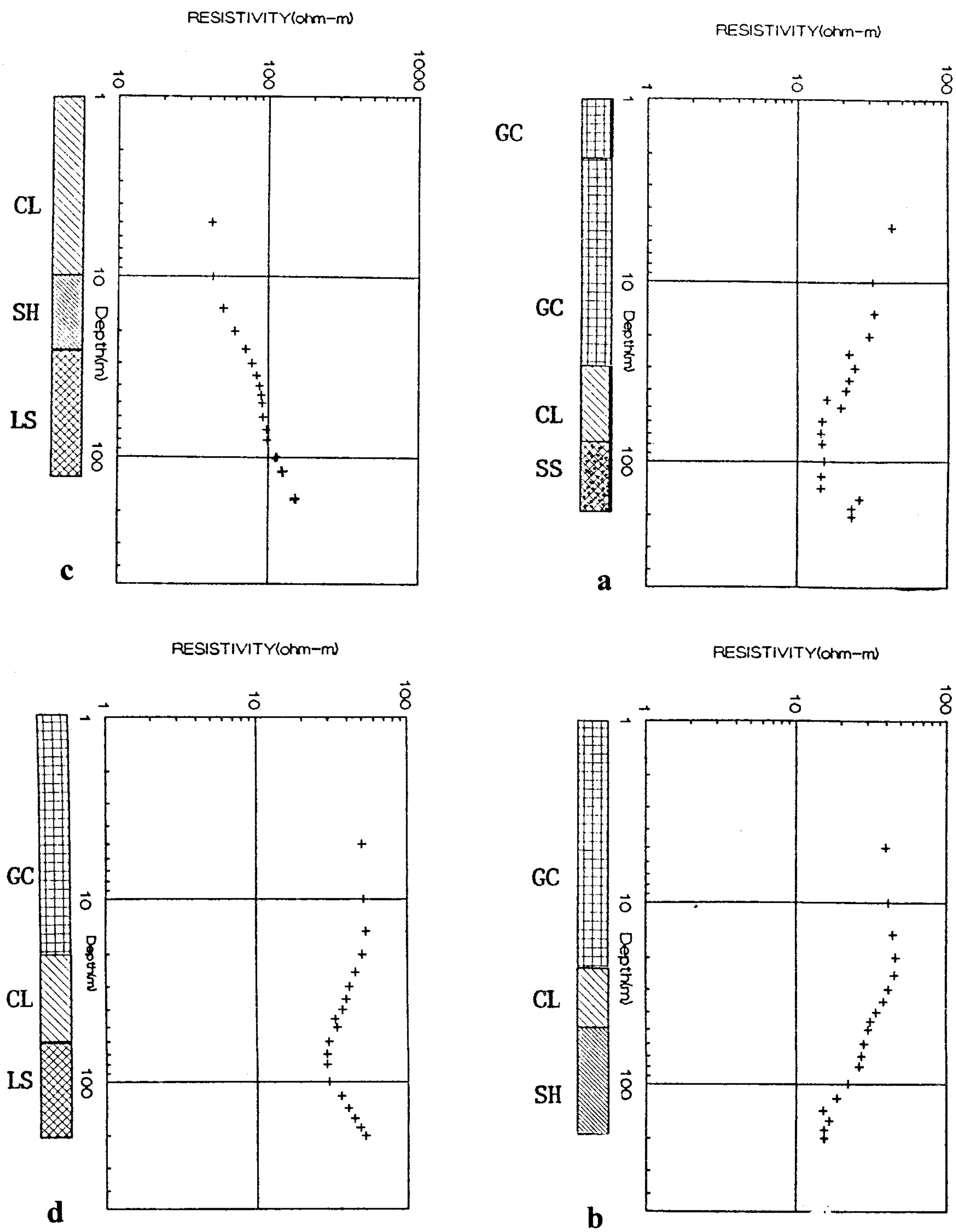

GC = Gravely Clay   CL = Clay   SH = Shale
SS = Sandstone   LS = Limestone

Figure 3 - Vertical Resistivity Profiles

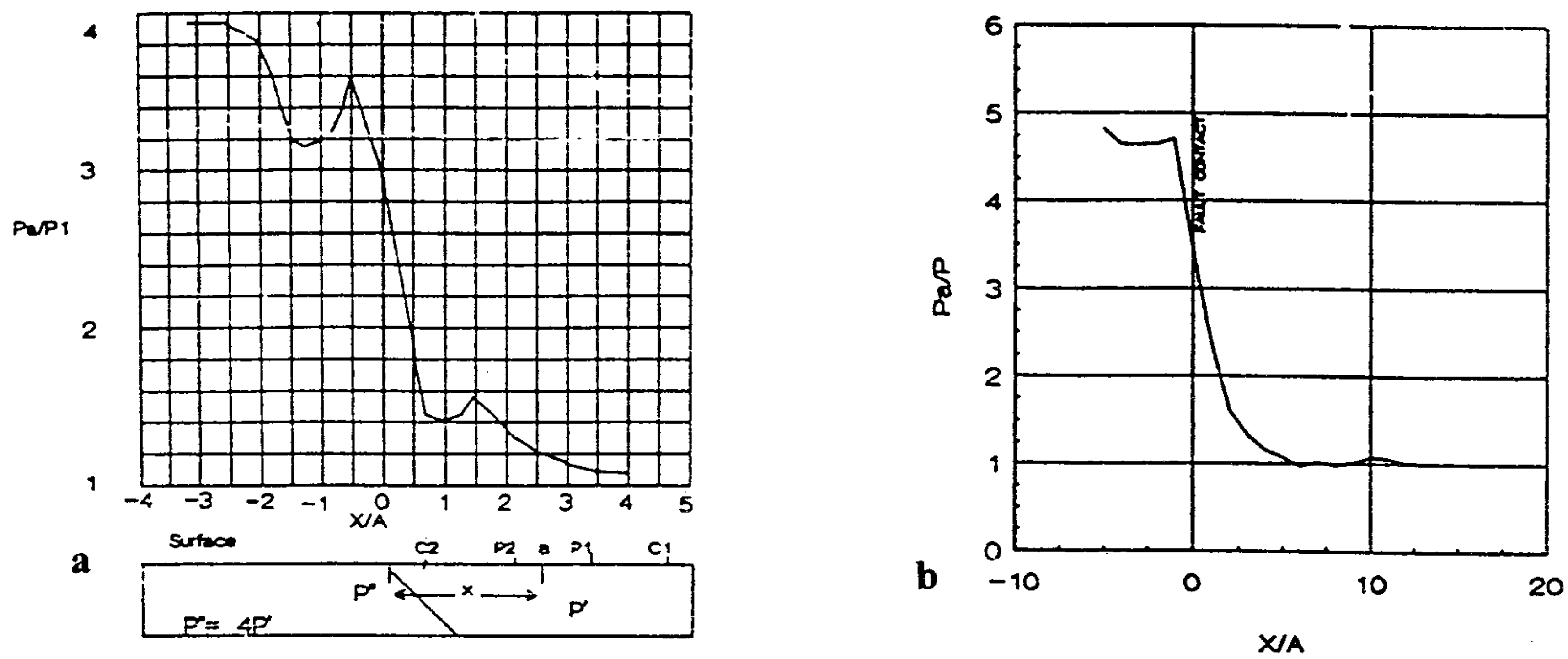

Figure 4- Resistivity peaks

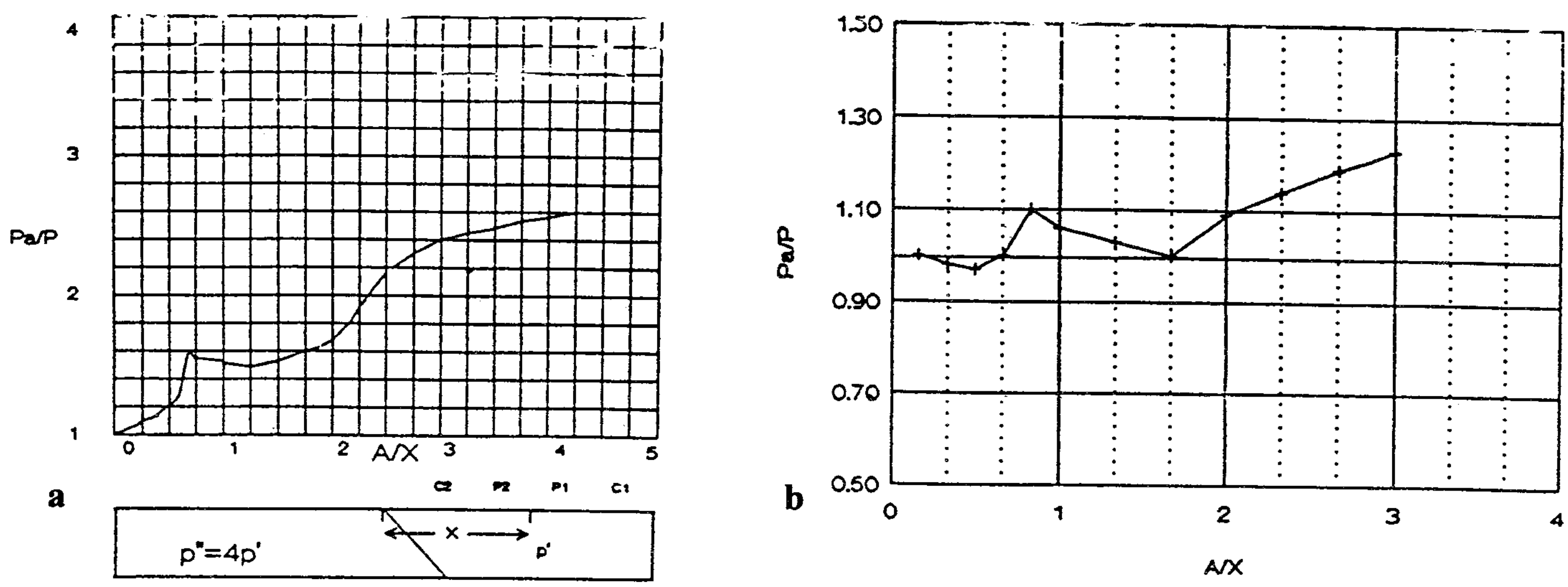

Figure 5- Resistivity peaks