Magnetotelluric data from the Tien Shan and Pamir continental collision zones, Central Asia

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1 Intoduction

We present magnetotelluic (MT) data obtained within the framework of the multi-disciplinary Tien Shan - Pamir Geodynamic Program (TIPAGE). The dynamics of the Tien Shan and Pamir orogenic belts are dominated by the collision of the Indian and Eurasian continental plates. With the geophysical components, we intend to image the deepest active intra-continental subduction zones on Earth (the N-dipping Hindu Kush and the S-dipping Pamir zones) and to establish how the highest strain over the shortest distance that is manifested in the India-Asia collision zone is accommodated structurally. The Tien Shan-Pamirs mountain knot forms the northwestern corner of the India-Asia

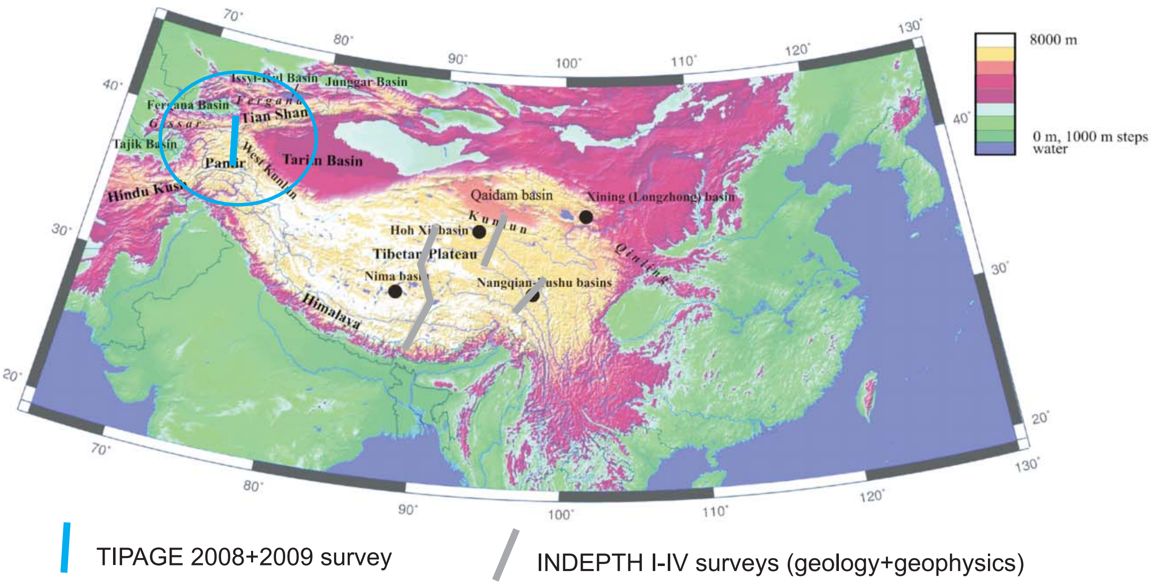

Figure 1: Central and eastern Asia orogens. TIPAGE and INDEPTH surveys are marked on the map. TIPAGE investigation area lies inside the blue circle.

collision zone and the Pamir-Tibet Plateau (Fig. 1). Note that N - S shortening in the Pamir and western Tien Shan is absorbed in less than 50% of the distance than further east. Basins denote areas little affected by intra-continental shortening. The Pamir excels over the adjacent Tibet by including the most active areas of intermediate-depth seismicity in the world and by far the most active one not associated with oceanic subduction, three coevally active, thick-skinned, high-strain contractional belts and four distinct intra-continental magmatic belts.

2 Measurements

The MT data were recorded in summer 2008 at 80 stations in the Pamir mountain ranges in Tajikistan and in summer 2009 at 98 stations in the Pamir and the southern Tien Shan in Kyrgyzstan and Tajikistan(Fig. 2). A typical spacing was approximately 2 km between BB-only sites and 14 km for the combined BB+LMT sites. The stations form an approximately 340 km long profile from Osh in Kyrgyzstan via Sarytash, the Kyrgyz-Tajik border, Karakul and Murgab to Zorkul in southern Tajikistan.

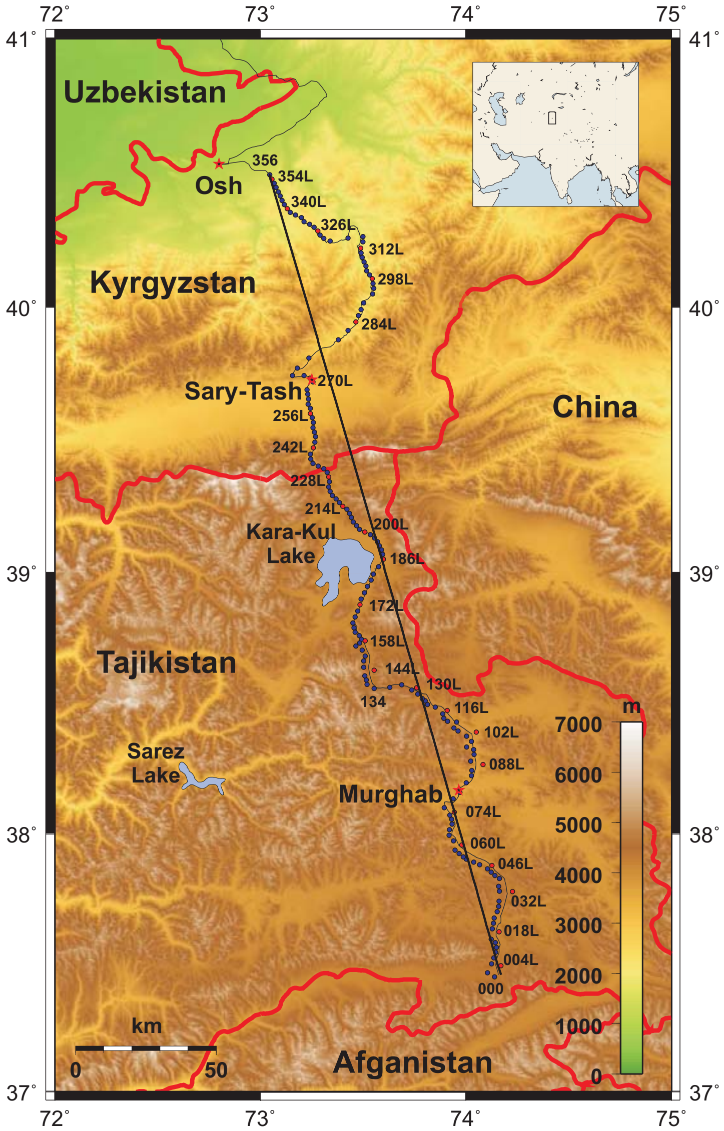

Figure 2: Topographic map with stations and profile of the TIPAGE survey. Numbers of stations with broad band and long period measurements (L) are marked. The station alignement follows the a single road in that remote area with rough terrain.

3 Preliminary Data Analysis

Data examples

Some representative graphs of apparent resistivities and phases are shown in Fig. 3. The curves were obtained after a recording time of three days, using robust single site processing. Varying shapes of the curves indicate considerable changes in the underlying conductivity structure. The distances between the shown stations are approximately 50 km. For station locations, see Fig. 2. The overall data quality is superb, especially in the very remote southern parts of the profile.

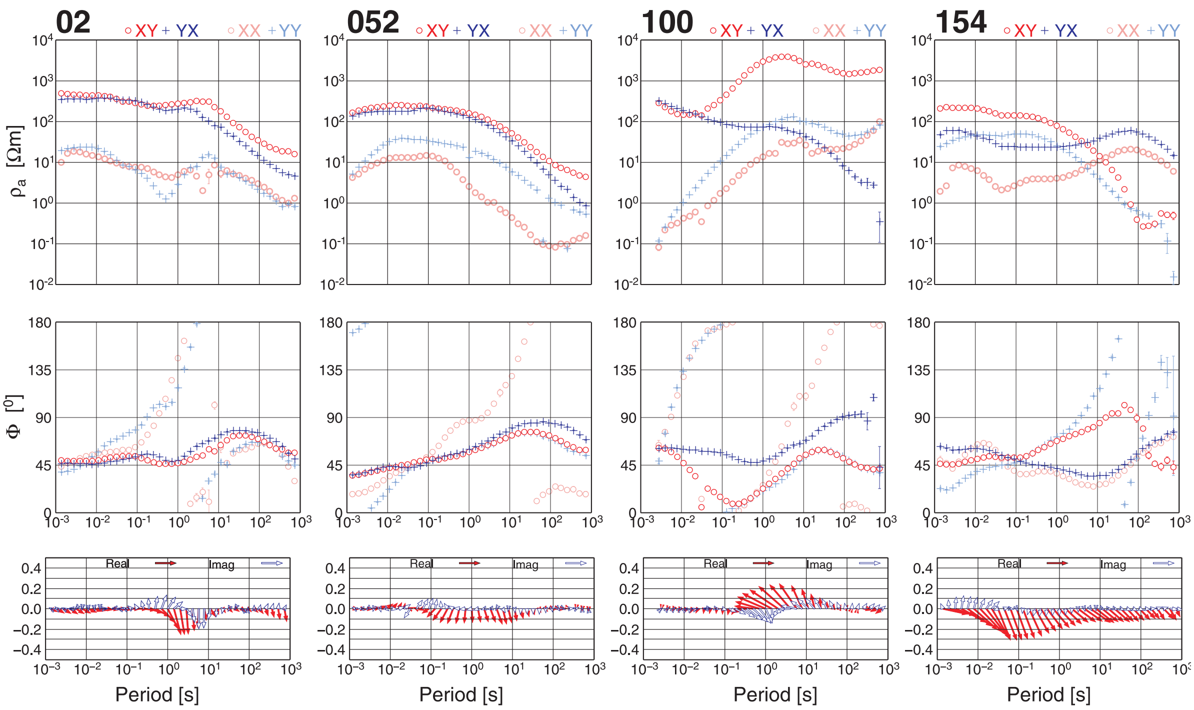

Figure 3: Exemplary apparent resistivity and phase curves of four broad-band stations from the Pamir. For station locations, see Fig. 2.

Pseudosections

Apparent resistivities and impendance phases of all TIPAGE stations are plotted as pseudo sections in Fig. 4. In the southern part of the profile, the TE and TM modes apparent resistivities show values below 10 Ωm at higher periodes and high phase values reaching 90°. There are more low-resistivity features further north at middle to high periods, which are more present in the TE mode. This hints at a deep conducting structure in the southern profile part and a complex distribution of conducting features in the northern segment of the profile.

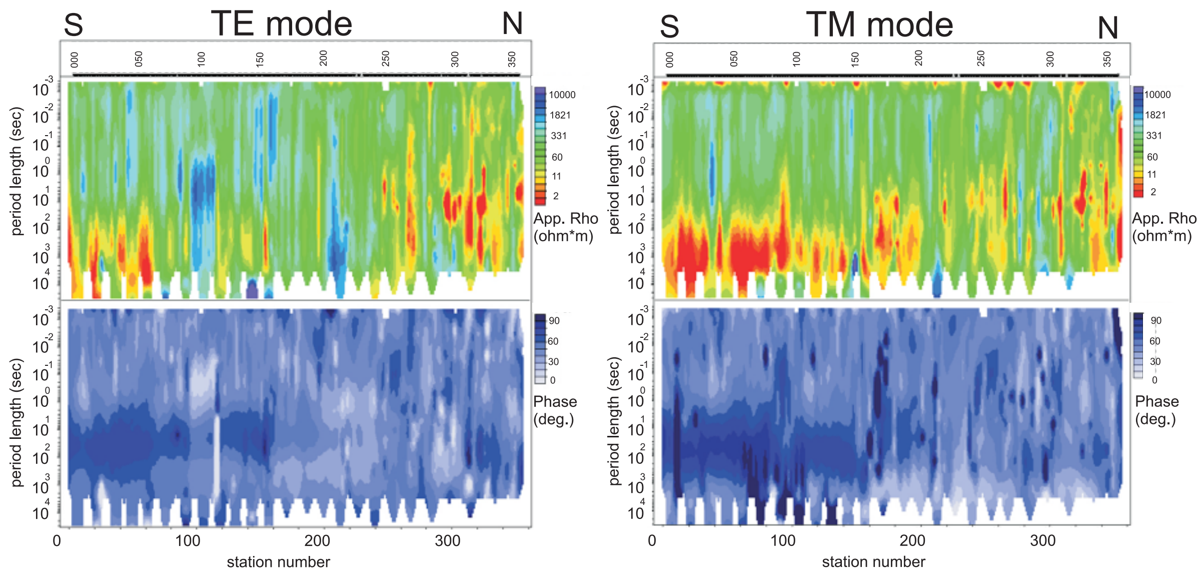

Figure 4: Pseudosections of apparent resistivity and phase data, in TE and TM modes. In the left part of each pseudosection the southern profile stations are plotted, in the right part the northern stations. For stations location, see Fig. 2.

Induction arrows

The presence or absense of lateral variation in conductivity can be inferred from induction arrow maps. In Fig. 5 induction arrows are plotted using the Wiese convention for periods of 1, 32, 128, and 1024 s. The arrow distribution indicates several 'reversals', which suggest the presence of elongated good conductors below the profile. Alltogether the induction arrow plots exhibit a complex distribution of the subsurface conductivity structure.

Strike analysis

Regional strike analysis (Becken & Burkhard, 2003) of sites recorded in the Pamir and Tien Shan is displayed in Fig. 6. The analysis of surface sensitive higher frequencies (Fig. 6 left) shows a E - W (N - S) strike direction. This is consistent with the predominant E - W distribution of geological structures. The lower frequencies (Fig. 6 right) reveal a pronounced geoelectric strike of approximately $-17°$ to $-20°$. This strike direction may be in agreement with structures of the India-Asian collision zone.

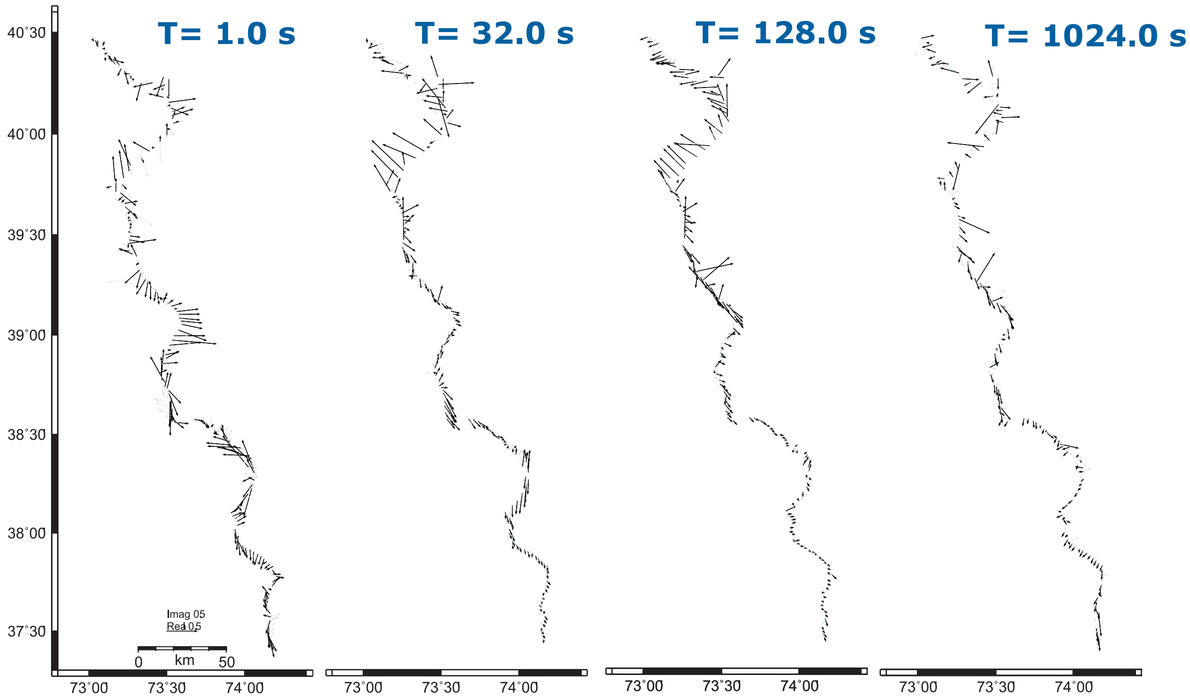

Figure 5: Maps of induction vectors (Wiese convention) for periods of 1, 32, 128, and 1024 s. Each arrow starts at one station location, compare Fig. 2.

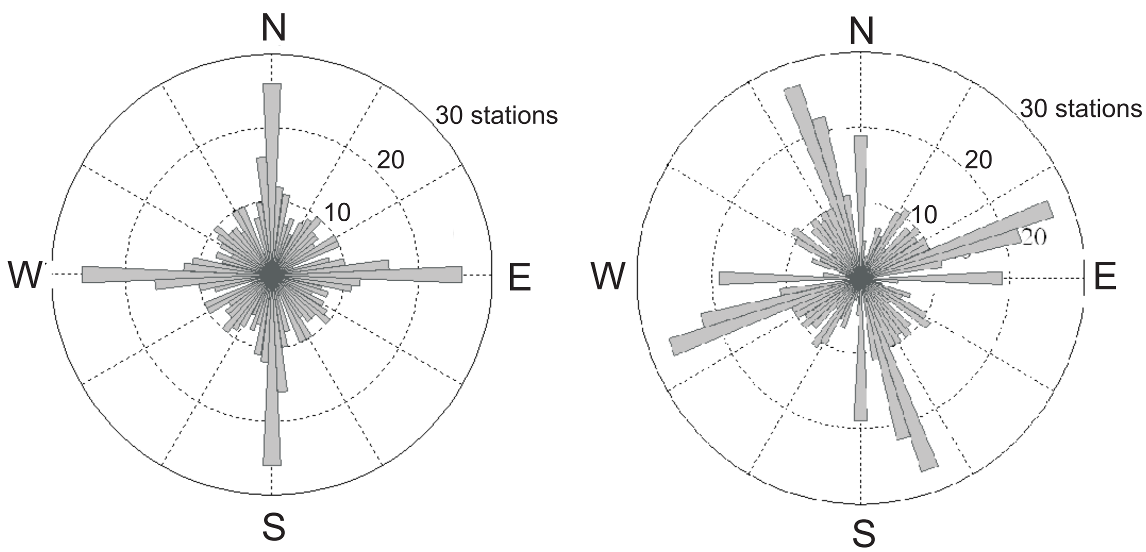

Figure 6: Regional strike analysis (Becken & Burkhard, 2003) of all sites recorded in the years 2008 and 2009. Left for the period range 0.001 s - 10 s, right for the period range 10 s - 10000 s.

Figure 7: The Kyrgyz/Russian - Tajik - German MT team of 2008 (left image) and 2009 (right image). The Research station of the Russian Academy of Sciences in Bishkek provided most of the field logistics, including 4WD vans and 4WD trucks.

Figure 8: The amazing hospitality of local people during the field campaigns was a memorable experience.

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