Preliminary interpretations of geophysical data of the Central Asia Orogenic Belt

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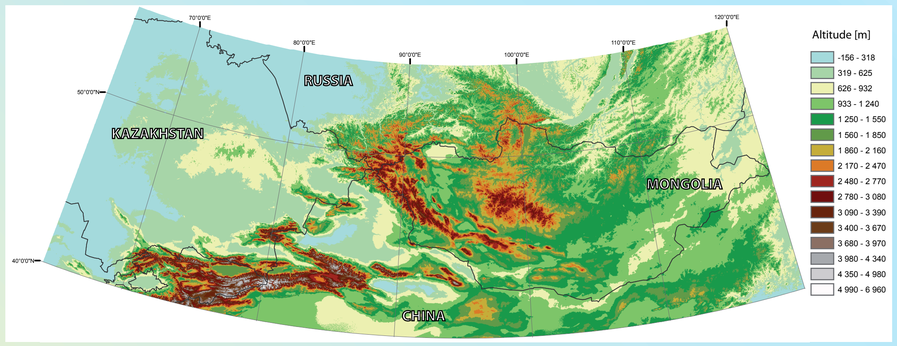
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Background:

Geophysical characterization of structures in the crust with constraints from geological and available seismic data, in order to define main tectonic zones. Preliminary results.

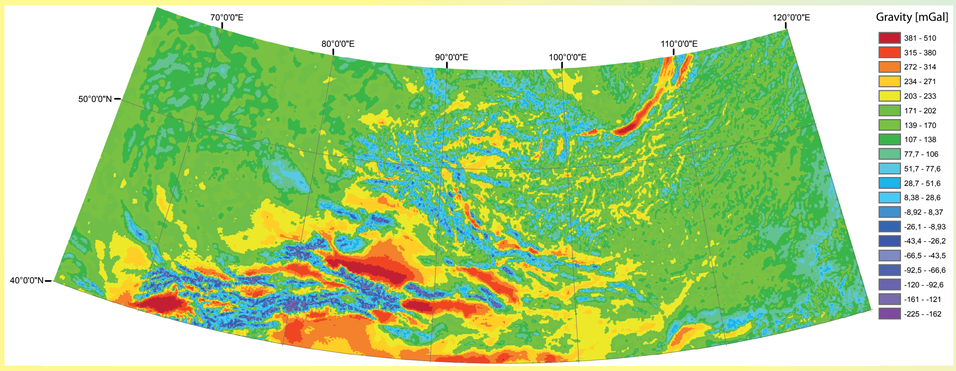


Topography (srtm 30)

Geographic system: WGS84
Projected system: Asia Lambert Conformal North Conic

The results of the potential field method has to be compared with the topography in order to evaluate its effects on the signal. Then the topography is a parameter used in the correction applied to potential field data.

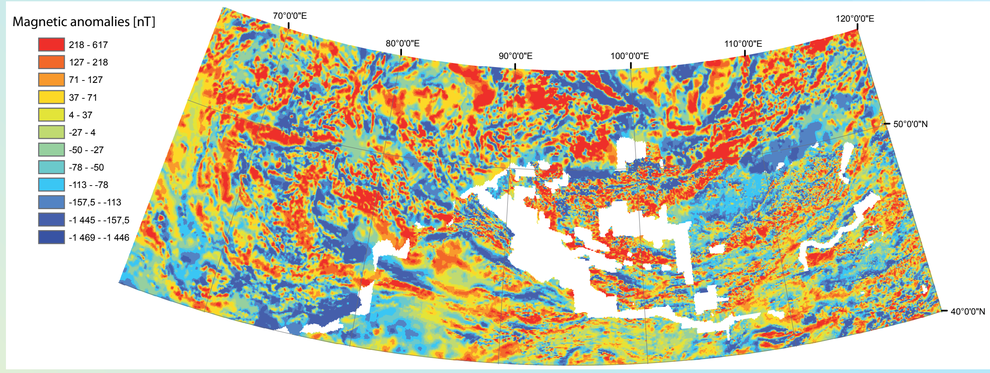
Free air anomaly map



The grid of free air data is from Ole Baltazar Andersen. The grid is with the resolution of 1 arc minute and is derived from available gravity sources.

The free air anomalies are correlated with the topography. To remove the topography effects on the gravity signal, the Bouguer correction has to be applied to the free air data.

Magnetic anomaly map

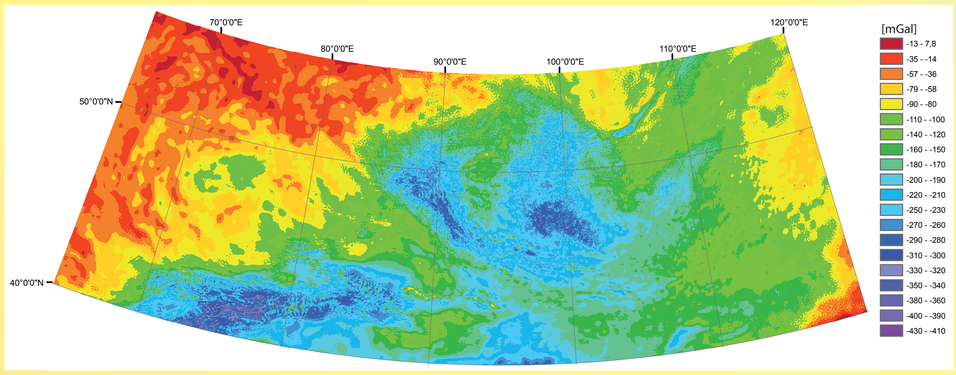


The grid of magnetic anomalies is from GETECH Database. The grid is with the resolution of 1 arc minute. Magnetic data are missing to the western part of Mongolia and at the borders with China.

Areas with high frequency and high amplitude alternate with areas with low frequency and low amplitude. No correlation between the topography and the magnetic anomaly map can be established as it is often the case.

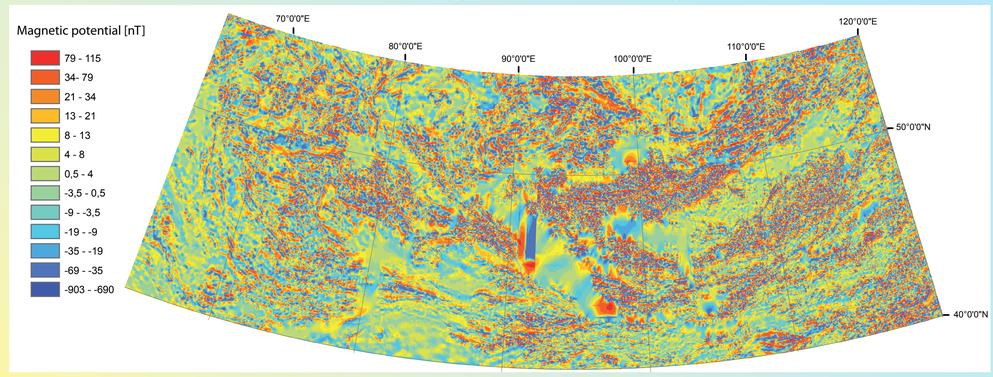
Simple Bouguer anomaly map: Bullard A correction

$$g_{cor} = 2\pi G\rho h$$



The simple Bouguer anomaly map still displays some correlation with the topography. In the western part of Mongolia, high topography is correlated with low gravity signal and low topography with higher gravity signal. This can be observed in most part of the map except for the Trans-Altaï area where the high topography corresponds to higher gravity values.

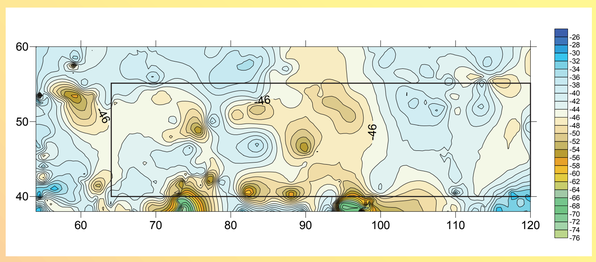
Vertical derivative of the magnetic anomaly map

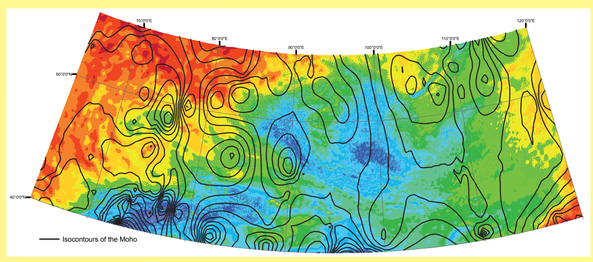


The vertical derivative is computed in the Fourier domain. The goal of this transformation is to increase the differences between the two kind of anomalies described before.

Using this map, it is then possible to delimite areas more accurately.

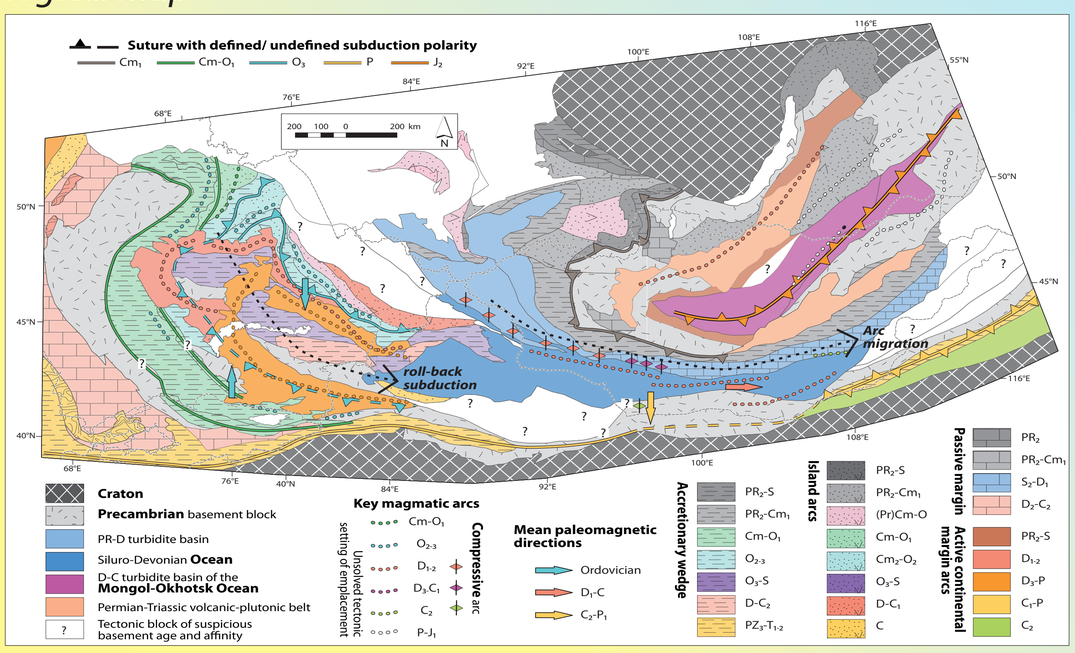
Map of the Moho and Bouguer anomaly map with isocontours of the Moho depth





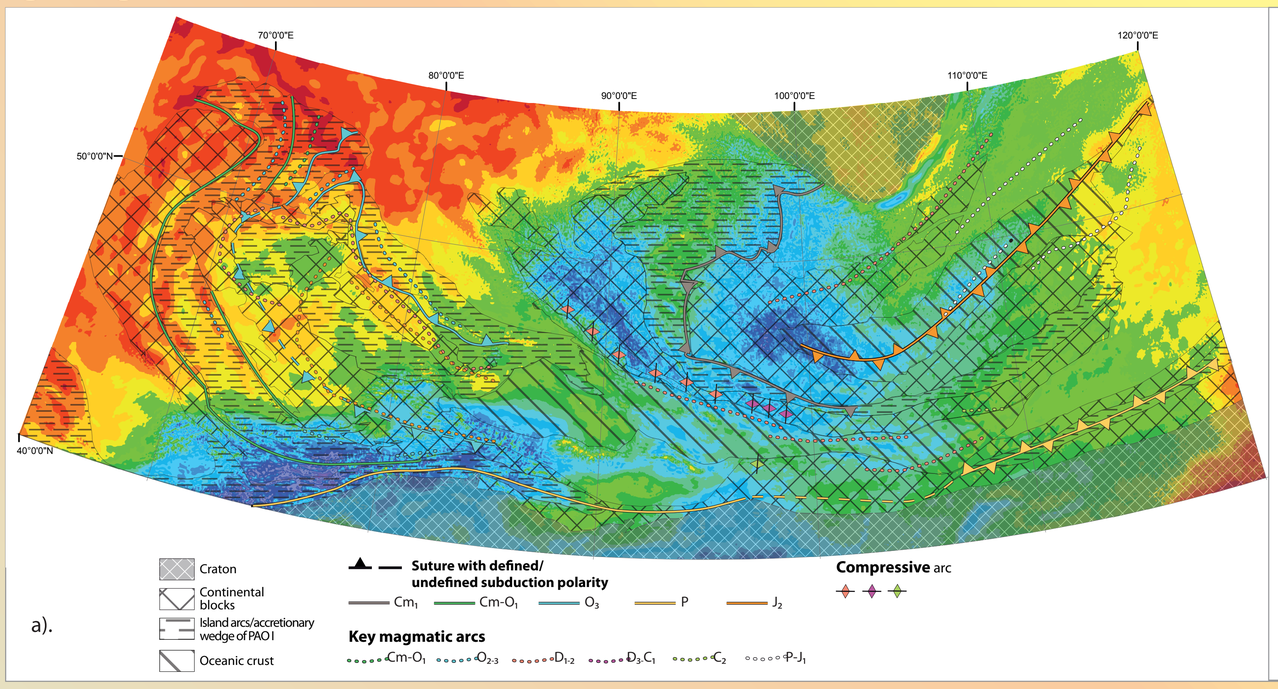
The map of the Moho depth is from the model CRUST 2.0. Into the area of interest, the variation of the Moho depth is from ~-35km to -50km. However, it is not a significant variation of depth for an orogeny context. Moreover, taking into account the average thickness in this area, the crust is considered to be equilibrated. Therefore, the gravity anomalies could come mainly from the density contrast in the crustal level.
A correlation between the Moho depth and the topography is not obvious. However, a global offset between the Moho depth and the main topography can be observed in the central part of the map.

Geological map

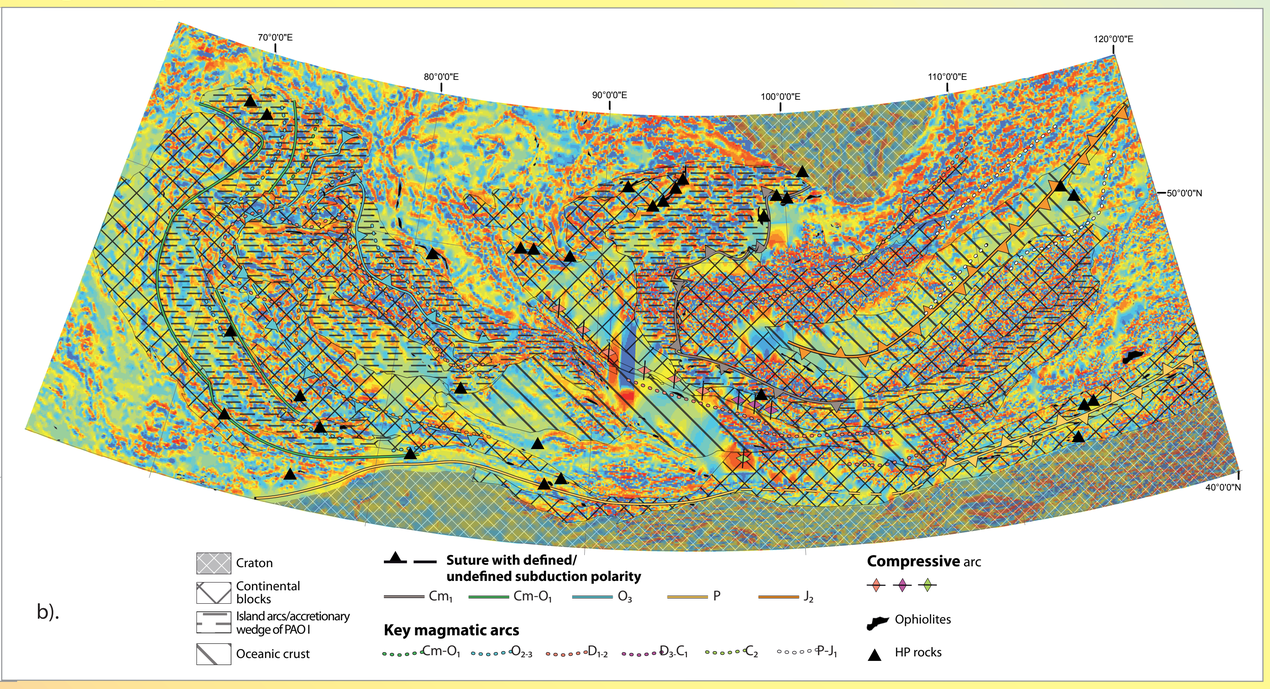


The Central Asia Orogenic Belt is an accretionary orogen. This orogen is built by accretionary wedges, island arcs, back-arcs, passive margins, continental blocks and finally, post-accretion granitics rocks.
At the Permian, all Proterozoic continental and juvenile material of arcs and back arcs were accreted to Asian cratonic nuclei thereby producing phenomenal continental growth. The Mesozoic period is dominantly marked by collisional processes and continuous shortening of space between southern cratonic masses and northern Siberian platform leading to strike-slip duplication of the crust and an oroclinal bending.

Preliminary interpretation of the Bouguer anomaly map correlated with geological data



Preliminary interpretation of the magnetic map correlated with geological data



a). The simple Bouguer anomaly map of the CAOB shows that the belt is today composed by areas marked by contrasting gravimetric signals. The oceanic crust which covers large areas of the Central Asia (more than 20%) shows most of the time denser crust and alternates with lower density crust of similar thickness (apart of Hangai mountains where the crust is anomalously thick). The Bouguer anomaly map shows that the Trans-Altaï Zone is characterized by higher gravity values compared to adjacent continental crust. Therefore, the Trans-Altaï oceanic crust is probably marked by high-density lower crust. This feature is underlined by the presence of intermediate to mafic granulite xenoliths in Tertiary volcanoes (sometimes with garnet) showing pressures around 10 kbar and confirming the crustal thickness of 40 km depicted by the geophysical data (Mooney et al., 1998). A similar gravity anomaly coincides with the outcrops of Lake Zone oceanic material to the north. However, in Kazakhstan, the signal is less clear due to a large scale positive gravity anomaly in the NE and more detailed geophysical work is needed there. In contrast, the main gravity low coincides with continental crust rich in siliceous plutons related to the Devono-Carboniferous magmatic activity. The occurrence of such anomalous crustal structure forming one of the largest orogens in the world shows that so far non identified processes may form thick "oceanic" crust of high density which forms integral part of continents.

b). The vertical derivative magnetic map reveals well defined boundaries of the Siberian craton to the north and Tarim and North Chinese cratons to the south. These areas are marked by low frequency low amplitude signals. In contrast the area of Mongolian and Kazakhstan basement oroclines are well defined by regions of high frequency high amplitude signals. The suture zone related to the Lake Zone is marked by accumulations of highly magnetized ophiolitic and HP rocks corresponding to high frequency anomalies. We observe also a markedly low frequency low amplitude signal area corresponding to homogeneous pelagic sediments associated to Mongol – Okhotsk ocean contours. The Trans-Altaï is characterized by presence of higher frequency anomalies corresponding to the outcrops of magmatic arc volcanics (except for the Tarim basin where the frequency is low). In the Kazakhstan, the spectacular high frequency high amplitude anomalies correspond to contours of Paleozoic arcs. Therefore, the magnetic data provide information about detailed subsurface orogenic structures (trends of magnetic arcs, sutures and trapped oceanic basins) which will be complementary to deep signals depicted from gravity and seismic refraction data.

Our geophysical preliminary results seem to confirm the oroclinal bending of Kazakhstan and Mongolian orogenic fabric. At key oroclinal area, the modeling step will provide constraints of the structure of the whole crust.

Future works

Apply Bullard C corrections to the gravity data : $g_{cor} = G\rho \left\| x*\ln(r+y) + y*\ln(r+x) - z*\arctan\left(\frac{xy}{zr}\right) \right\|_{x_1,y_1,z_1}^{x_2,y_2,z_2}$ where $r = \sqrt{x^2+y^2+z^2}$ in order to completely remove the topography effects and to evaluate the influence of the isostatic anomalies on the gravity data.

3D gravity models of the two areas of interest: Lake zone and Trans-Altaï zone. The modelisation will be constrained by geological and available seismic data.

Apply further treatments and filters on the magnetic data in order to have better ideas of the structures.

3D magnetic models of the two previous areas.