Russian Geological Research Institute

Tectonic structure and metallogeny of the Western Chukotka: insights from comprehensive geophysical dataset interpretation.

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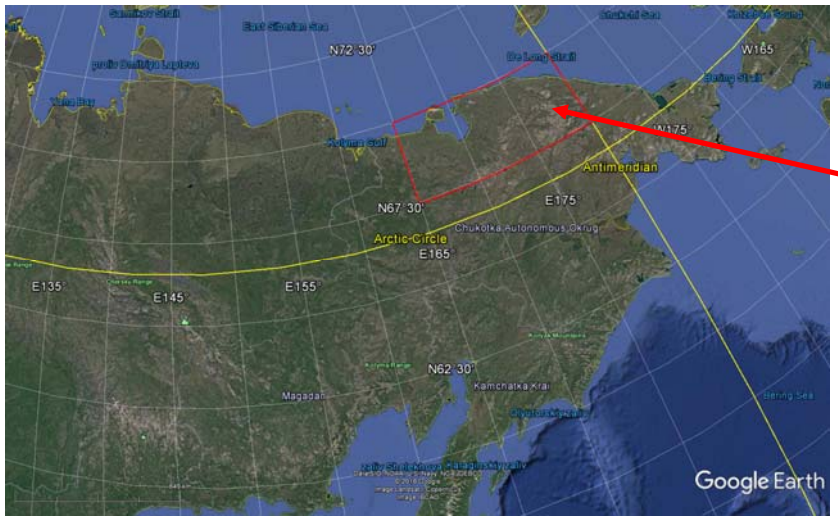
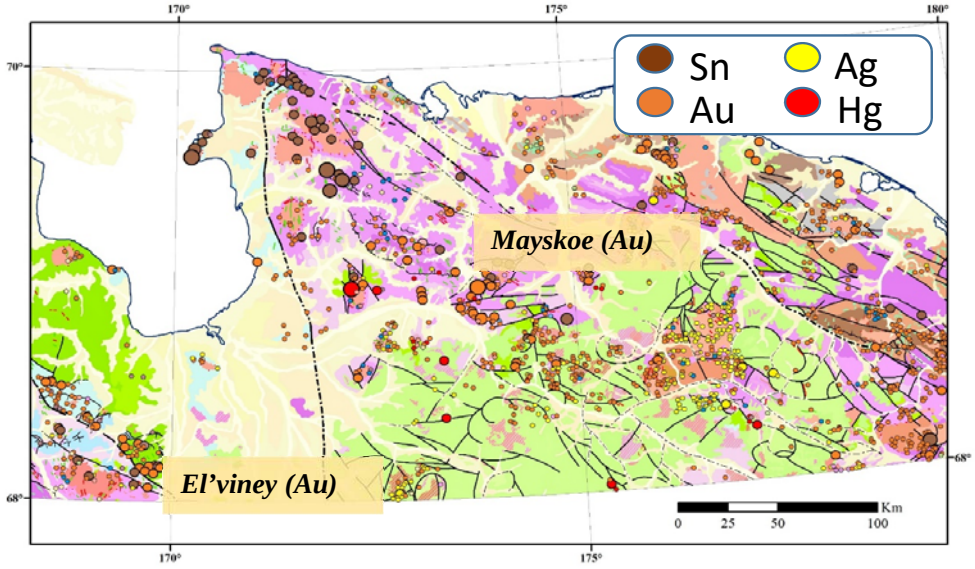
Introduction

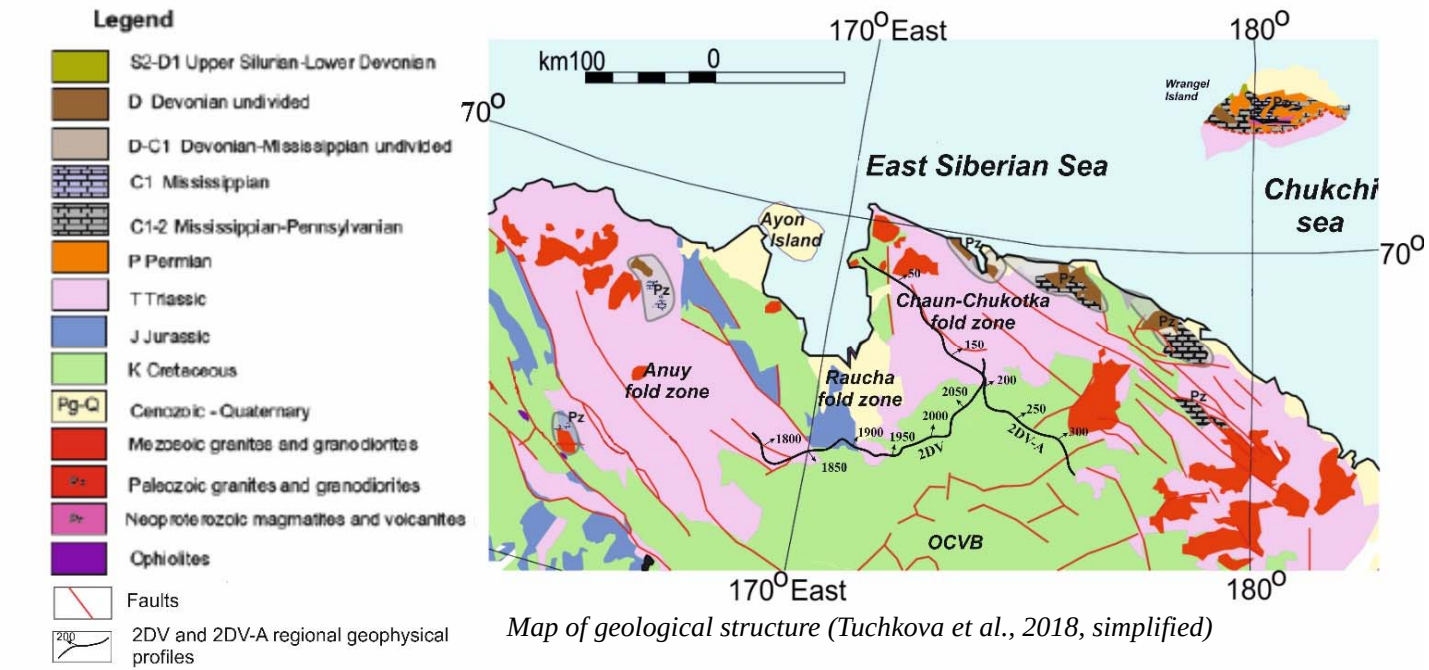


The investigated area is located in the Far East of Russia and it is a part of Chukotka fold belt. That is the result of the collision of the Chukotka microplate with Eurasia. The geological structure of the region is poorly studied except the areas of ore deposits due to the flat topography and few numbers of outcrops.

The main reason for comprehensive study of the area is its very high ore potential (tin, gold, silver and mercury). The largest gold deposits are Mayskoe (100 tons) and El'viney (60 tons). Thereby, the geophysical methods take the leading role in the geology structure understanding.



Geological settings



Map of geological structure (Tuchkova et al., 2018, simplified)

Four general fold zones are observed. Stratigraphic units from Devonian to Triassic in Chaun-Chukotka and Anuy structures (or to Cretaceous in the Rauchua Basin) are involved in a series of map-scale folds. In the Kuul' uplift is located the Eastern part where the Pz formations outcrop. Cretaceous plutons cut all fold-related structures of the Chukotka belt. The intrusion of Cretaceous plutons represents a major change in tectonic regime from compression to extension. Volcanic sequences of the Okhotsk-Chukotsk Volcanic Belt (OCVB) overlie all older rocks in Chukotka, including the Cretaceous granitoids, along a profound, regionally developed angular unconformity.

The aims of joint geophysical data analysis and interpretation:

- **Detection of rocks movements directions along the main tectonic faults;**
- **Estimation of the thicknesses of different rocks formations and also of OCVB volcanic rocks;**
- **Mapping of covered intrusive bodies and surrounding metamorphic zones t~~hem~~;**
- **Investigations of general regularities of ore deposits distribution connected with tectonic features of the area;**

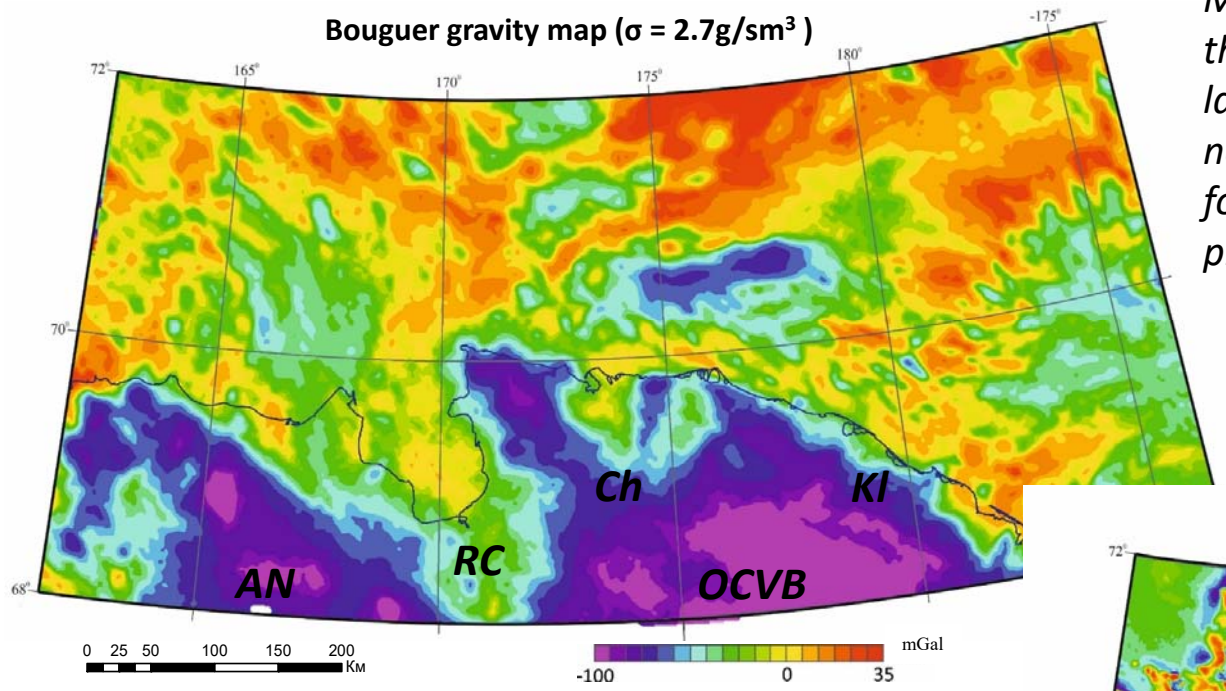
The follow geophysical data were used in the study

- the results of airborne magnetic and gravity surveys of Chukotka fold belt;

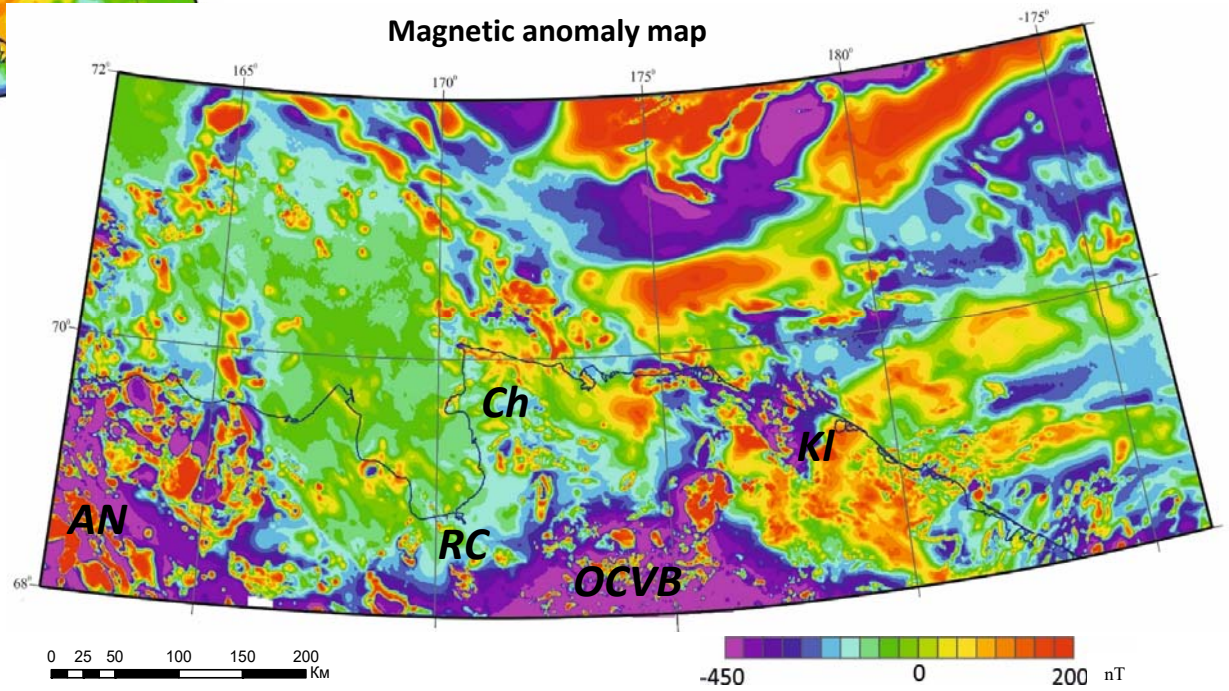
- the magnetotelluric data along two regional profiles 2DV and 2DV-A;

- the seismic (CDP, DSS) data along two regional profiles 2DV and 2DV-A.

Tectonic structure according to potential field data



Main structures of NW direction are clearly observed in the potential field data. OCVB volcanic rocks manifest as large negative value area in the magnetic field data and negative anomaly in gravity data. In the NE part the folded structures of Arctic Ocean that have the WE prolongation are detected.



Structures of Chukotka fold area:

AN – Anuy fold zone

CH – Chaun-Chukotka fold zone

RC – Raucha basin

OCVB – Ohotsk-Chukotsk volcanic belt

Kl – Kuul' uplift

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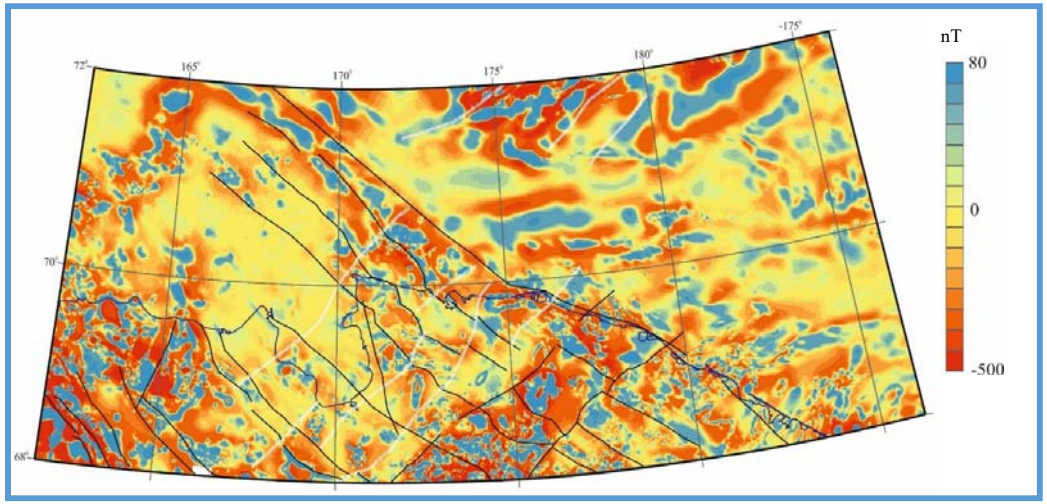
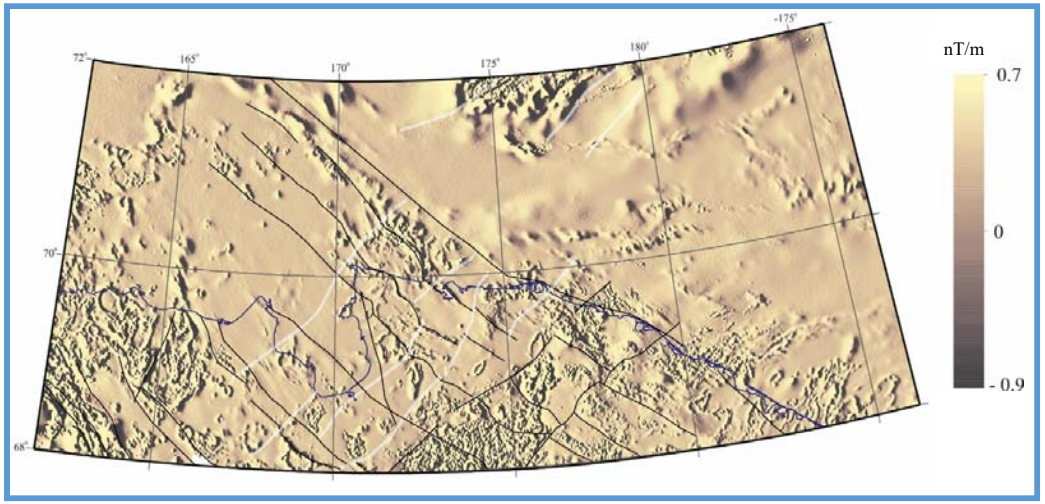
Tectonic structure according to potential field data

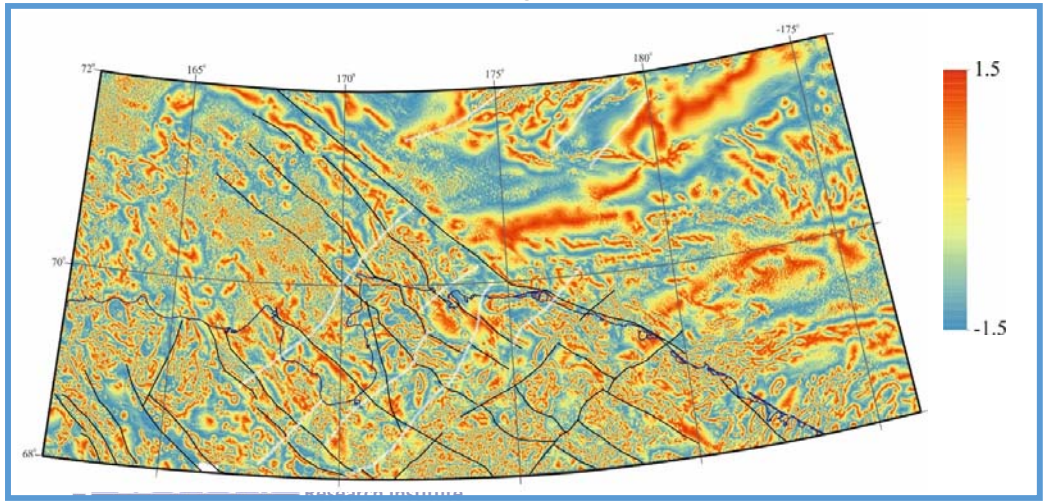
Butterworth high-pass filtered magnetic map



Horizontal derivative magnetic map

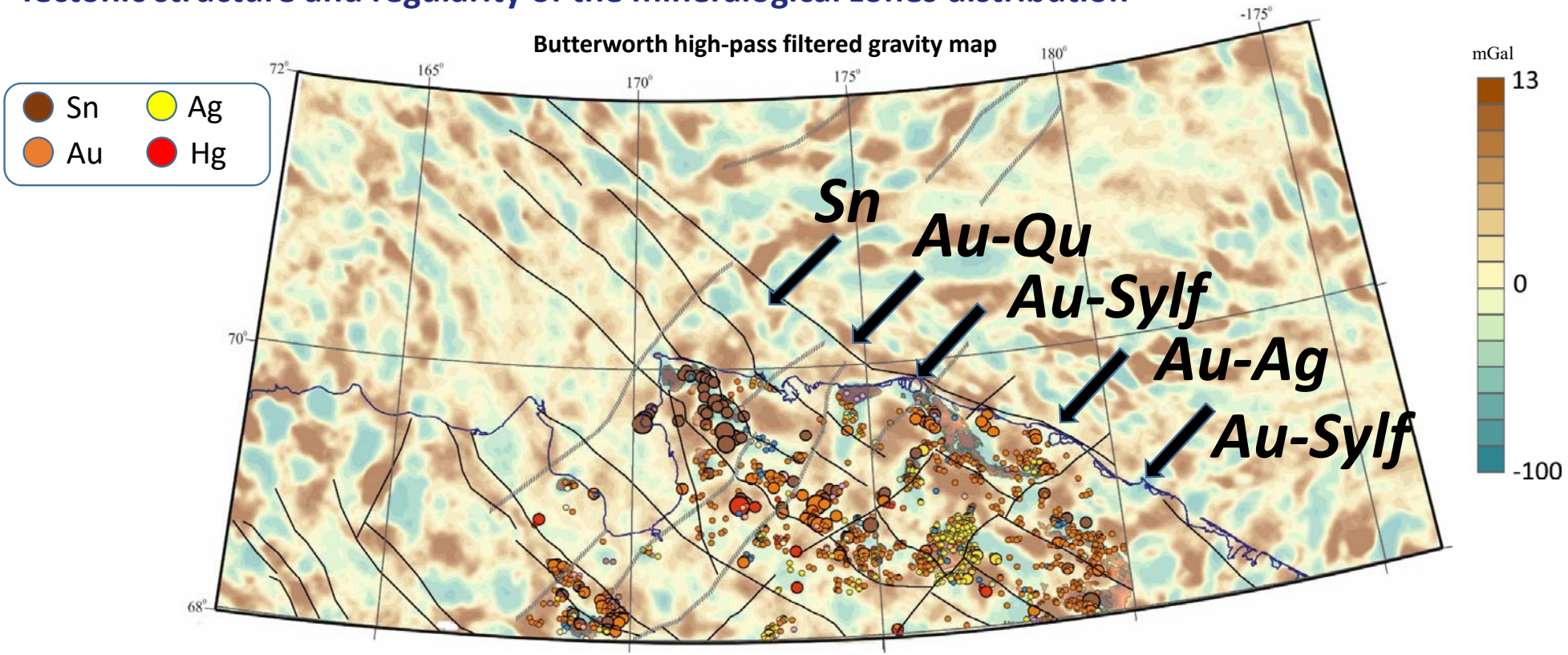


Tilt-derivative of magnetic data



For tectonic elements mapping we used high-pass filtered maps, horizontal derivative and tilt-derivative of potential field data. The known thrusts of NW direction (black lines in the maps) are detected clearly. In addition the NE oriented faults could be delineated (white lines).

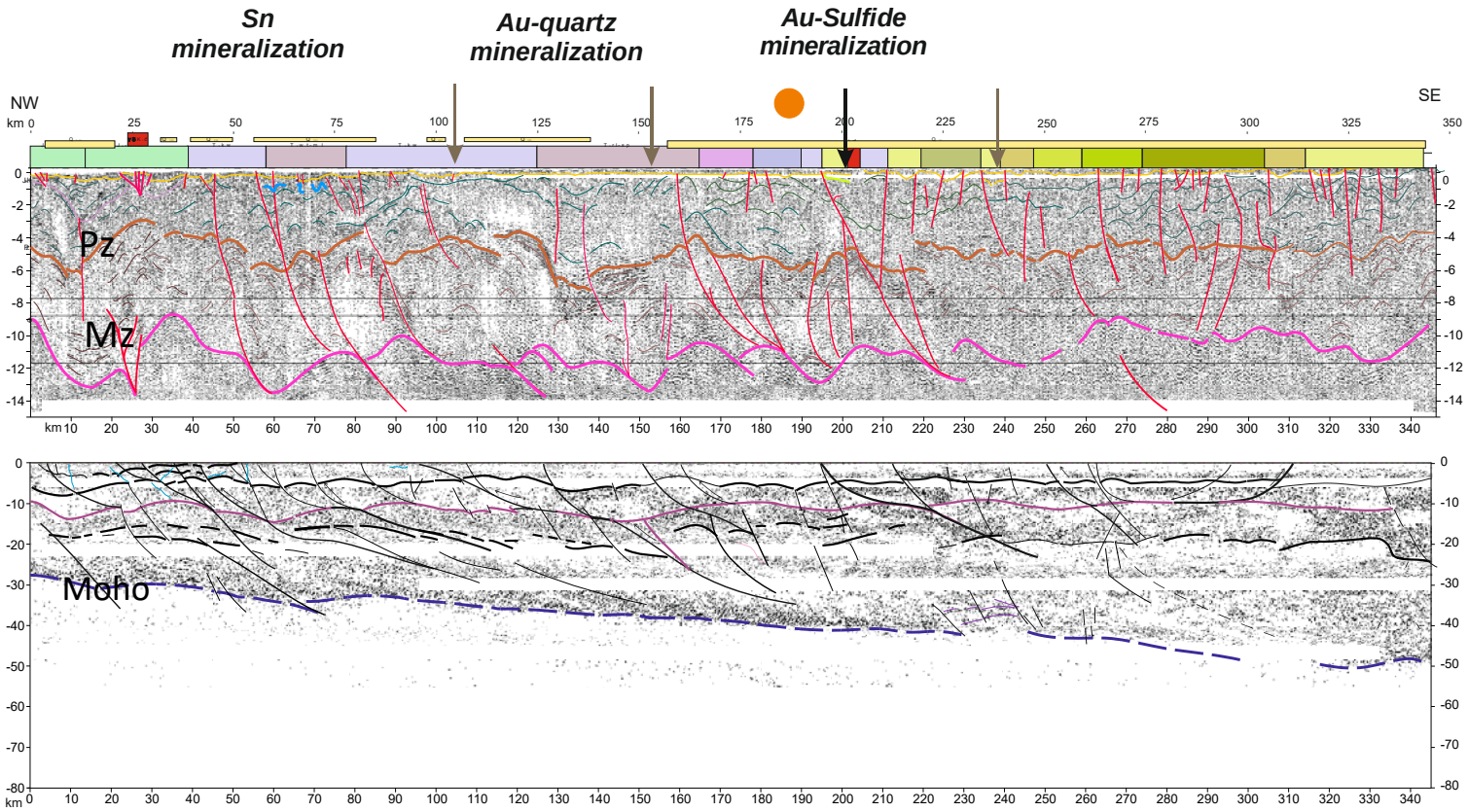
Tectonic structure and regularity of the mineralogical zones distribution



The two delineated faults system control the mineralogical zones distribution on the surface. We could see both NE and NW oriented zonation in the ore types distribution. The NW one is observed by the changing of ore appearances value, most of them are observed in uplifted blocks (Anuy and Chaun-Chukotka zones). In addition, we could see the NE oriented zones that are characterized by certain mineralization type. The tin mineralization is changed by gold-quartrs, then gold-sylfide and then to gold-silver. The delineated NE faults are the borders of these zones.

Deep structure along regional profile 2DV-A

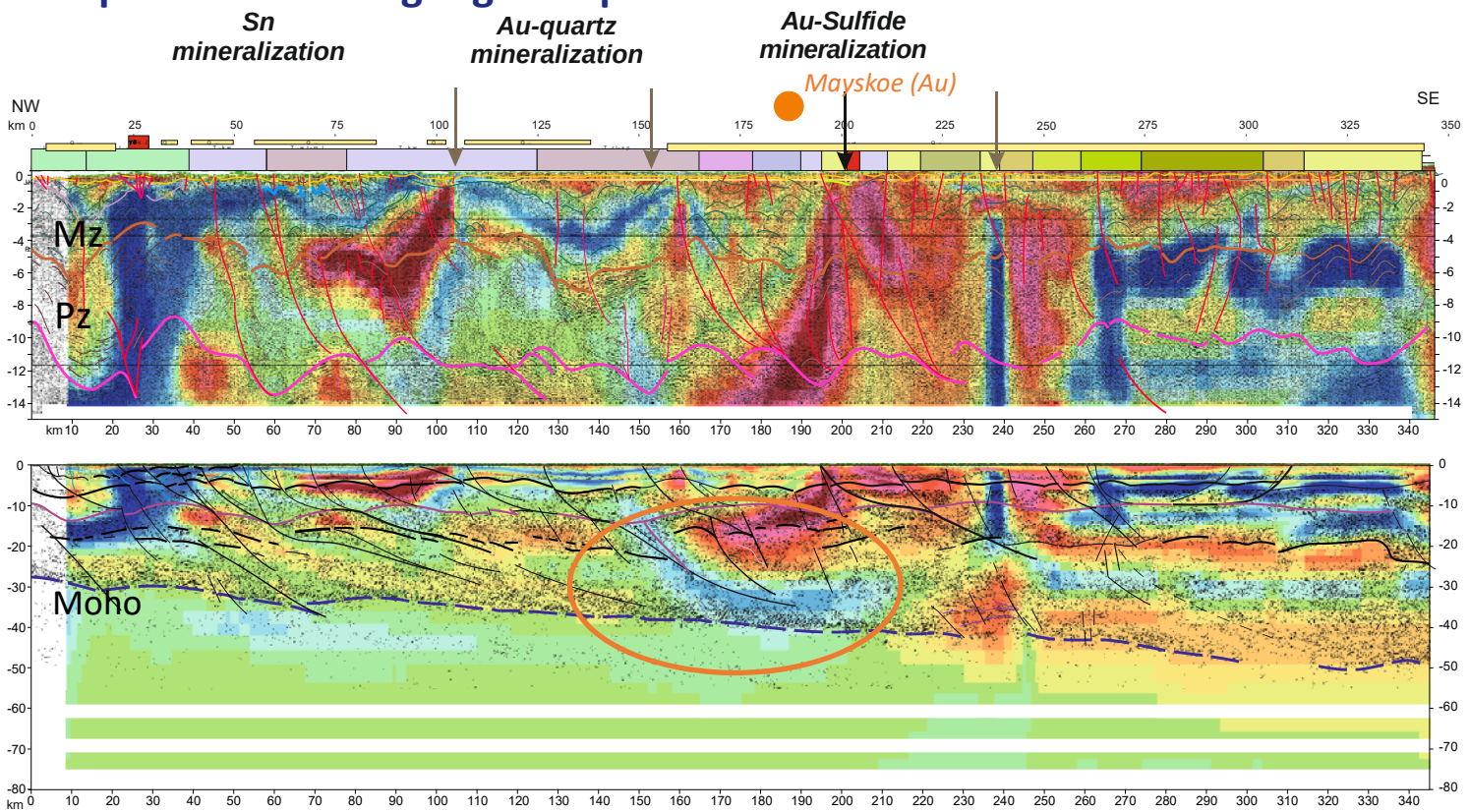
Seismic data along 2DV-A line (CDP and DSS)

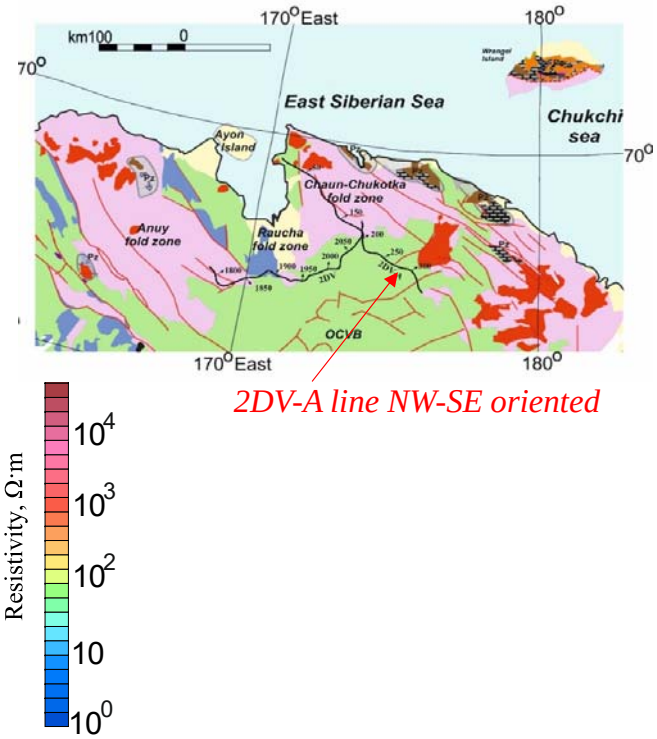


2DV-A line NW-SE oriented

*The seismic sections both for the upper and lower parts of the section along part of 2DV-A regional profile are shown. The Mz and Pz formations c**characterized by very** omplex structure of the wave field that is explained by the folded structure and presence of a lot of intrusions. The upper and lower crusts with the border between them at about 20 to 25 km depth are detected.*

Deep structure along regional profile 2DV-A

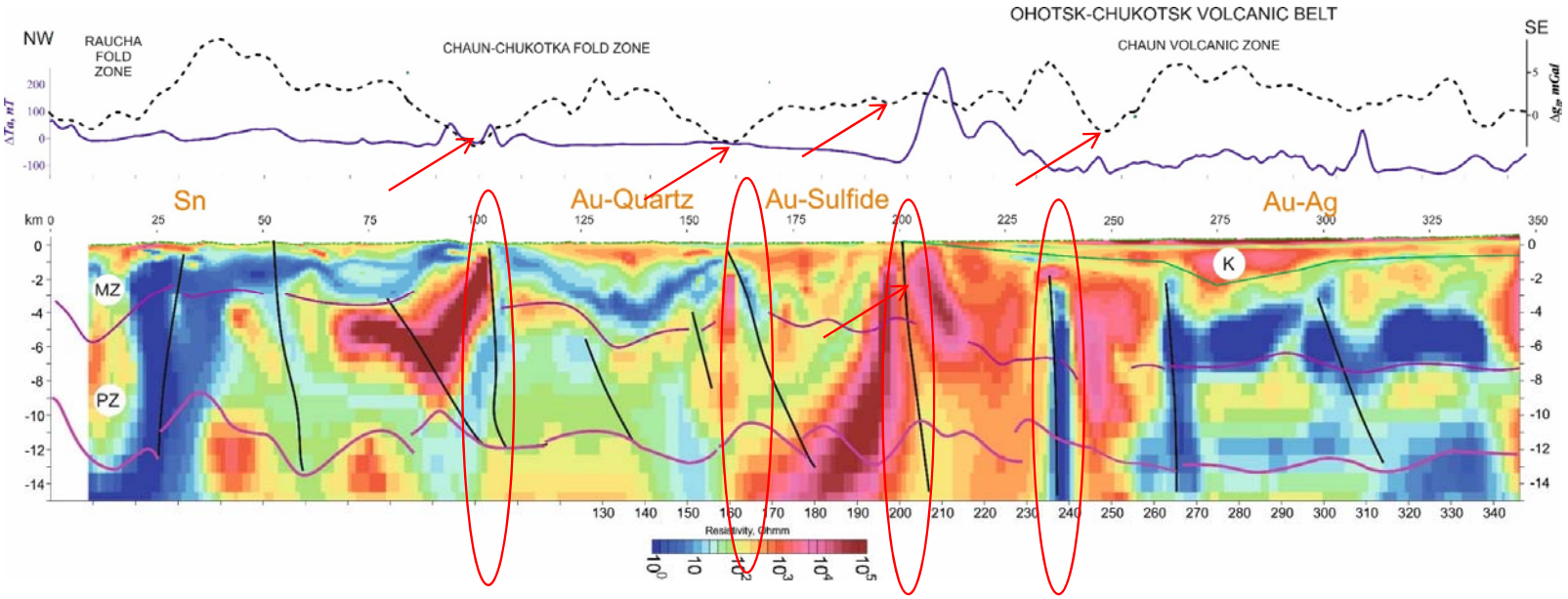


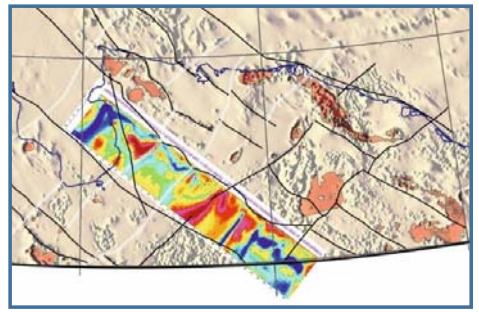


2D inversion results of Magnetotelluric data and results of seismic data interpretation

The seismic borders were used for magnetotelluric inversion. The obtained geolectric pattern of the area is also complicated. The borders between main formations could be detected. We could observe the conductive anomaly in the upper and lower crust that is very common for the gold bearing area, and the Mayskoe gold deposit is located in the area of the anomaly zone. But this criteria has a very regional value for the scale of our investigations. The folded structure of Pz and Mz complexes are also observed, and sever local high resistive bodies are detected.

Deep structure along regional profile 2DV-A



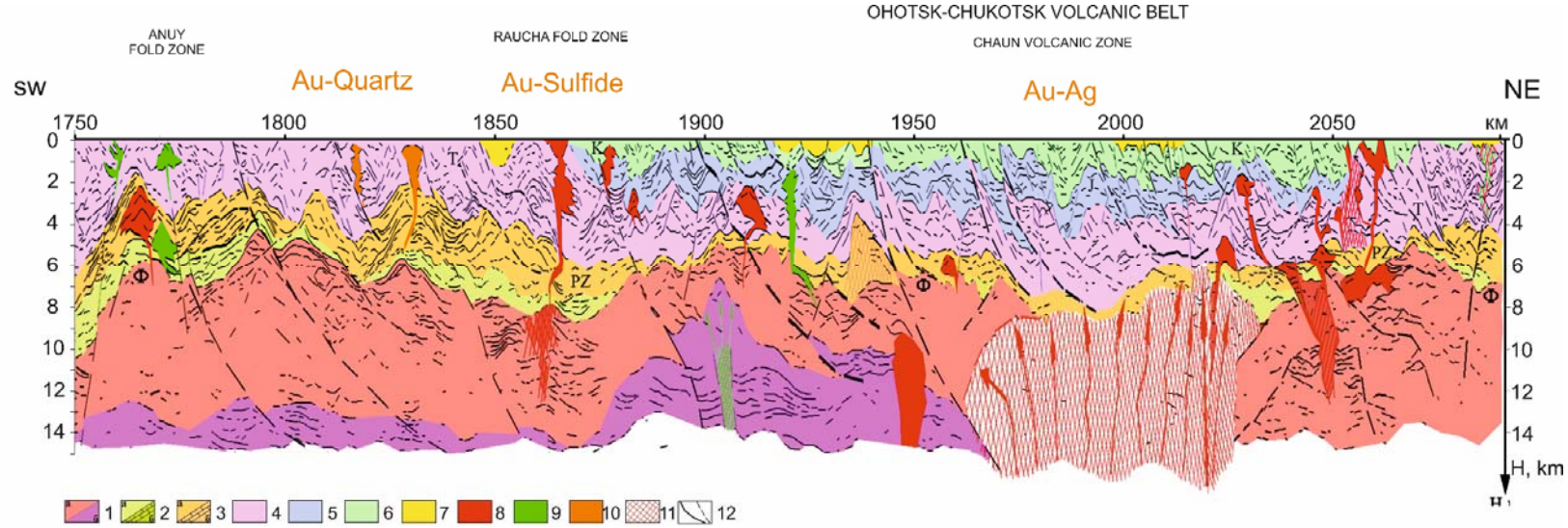


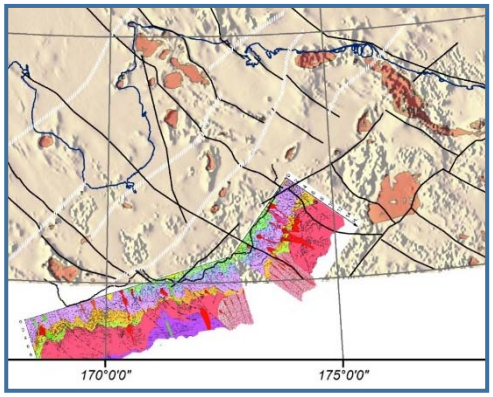
Segment of the horizontal derivative magnetic map and 2DV-A geoelectric section. The NE directed faults connected with sub-vertical conductive anomalies.

The geoelectric model for the upper part (up to 15 km depth) is shown. The NE directed faults delineated by potential fields data are connected with sub-vertical conductive anomalies. All of them are associated with resistive bodies that are accompanied by the low values anomalies in a high-pass filtered gravity data. So, we suppose that the delineated by potential field NE directed faults are filled with the granitic intrusions. These faults control the dipping of Pz basement in the SE direction (from about 3-4 km up to 6-8 km). At the surface, we observed the changing of mineralization type due to various erosion level of intrusion body which are the source of mineralization. The Sn mineralization is the most high-temperature, and it changed by less-temperature Au-Quarts and the Au-Sulfied with the dipping of Pz basement.

Deep structure along regional profile 2DV

Joint interpretation result (Surkov et al, 2008)





Segment of the horizontal derivative magnetic map and geological section along 2DV according to joint interpretation results. The NW oriented faults are sub-vertical but have a tendency to dip in the NE direction.

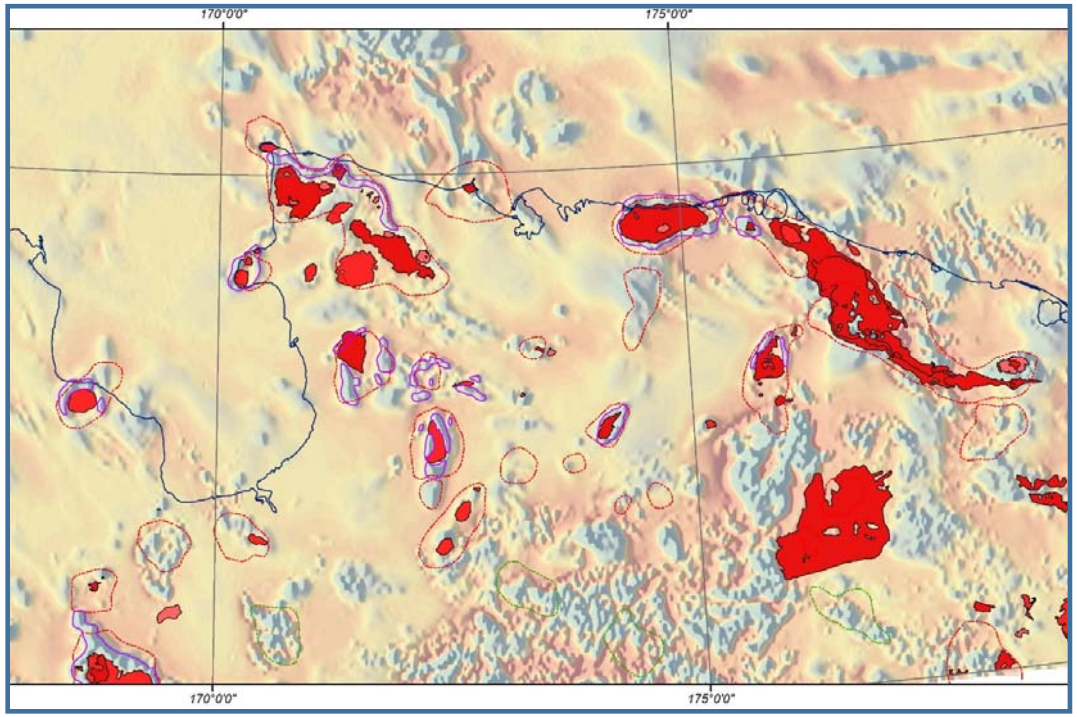
1 - AR-PR granite-gneiss-amphibolite formation. Sedimentary cover: 2 - PR_2-D formations, 3 - C- P formations,4 - volcanic-sedimentary formations (T), 5 - volcanic-sedimentary formations (J), 6- volcanic-sedimentary formations (C); 7 -supposed Cainozoic depressions. Intrusive formations: 8 - mainly acidic composition, 9 - mainly basic composition; 10 - alkaline composition (syenite); 11 - supposed zones of granitization, 12 - supposed zones of basification, 13 - regions of mixed geochemical specialization, 14 - zones of supposed ascending fluid flows; 15 - tectonic faults.

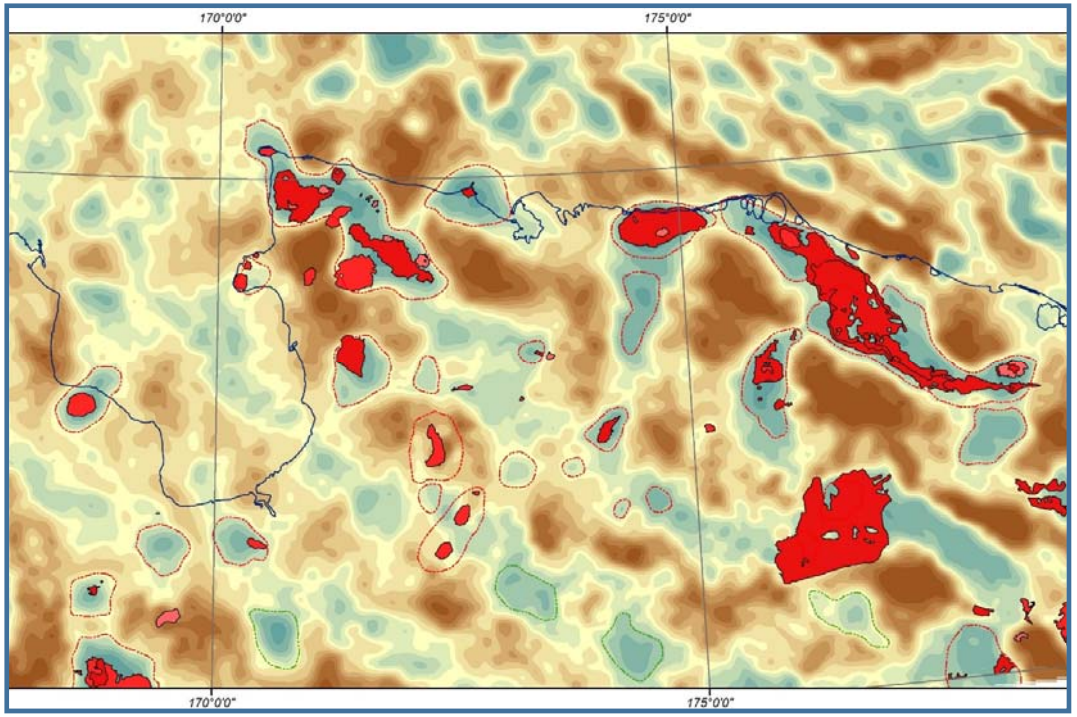
The geological model along 2DV regional profile according to joint interpretation of geophysical methods is shown. The general tendency of Pz basement dipping in NE direction is observed. The deepest part is allocated under the OCVB volcanic rocks. The basement structure is controlled by the NW oriented faults which are sub-vertical and generally dip in the NE direction. The mineralization type at the surface changes from Au-Quartz to Au-Sulfide and to Au-Ag. Thus, two mapped fault systems control the complicated block-structured pattern of the area that determines ore deposits distribution. For the deepest blocks we observe the less-temperature ore formations (Au-Ag and Au-Sulfide) and for the highest blocks the high-temperature formations (Au-Quartz and Sn).

Mapping of covered intrusive bodies and metamorphic zones surrounding them

The granitic intrusions are the main ore sources in the area and detection of the covered plays the important role in the ore promising sites allocation.

Butterworth high-pass filtered magnetic map





Butterworth high-pass filtered gravity map

The covered granitic intrusions are clearly detected according to the gravity data by the local negative-values anomalies. The zone of metamorphic alterations usually includes sulfides and appears in the magnetic data as local zones of positive magnetic value surrounding intrusion body.

Conclusions

The complex interpretation of geophysical data allows us to obtain following results:

- The tectonic structure of the area was obtained from potential field data;
- Deep structure along regional profiles was studied. The thicknesses of Mz, Pz complexes and upper and lower crust were detected. →

Obtained models along regional profiles have to be distributed to the area by the potential fields modelling (in future…);

- Two mapped fault systems of NW and NE direction control the complicated block-structured pattern of the area that determines ore deposits distribution at the surface. For the deepest blocks we observe the less-temperature ore formations (Au-Ag and Au-Sulfide) and for the highest blocks the high-temperature formations (Au-Quarts and Sn).

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