TECTONIC AND STRUCTURAL CONTROLS ON INTRUSION-RELATED DEPOSITS IN THE NORTHERN PART OF SREDNA GORA ZONE, BULGARIA

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BOR WORKSHOP 2007

INVESTIGATED AREA

Fig. 1. Geological sketch map of the area of Etropolska Stara planina mountain (Ivanov et al., 2004) based în the geological map of Bulgaria M 1:100 000

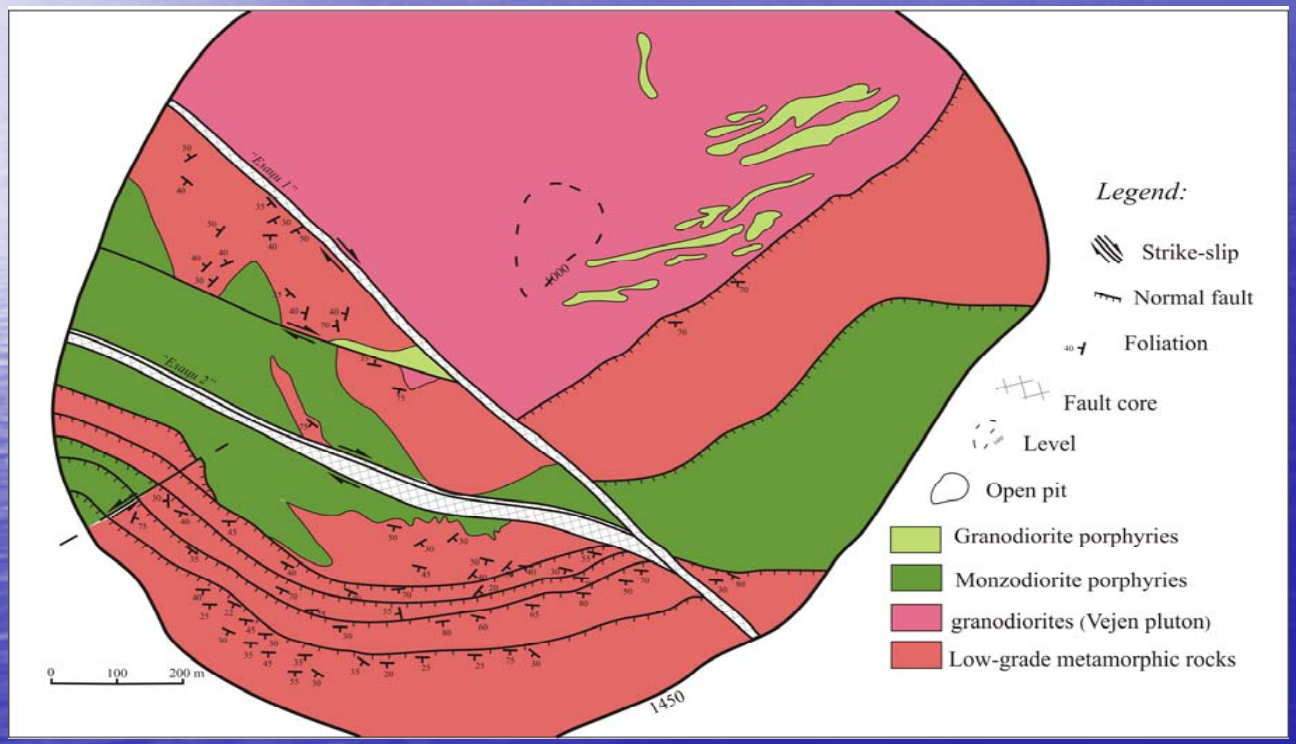
INVESTIGATION METHODS

- Detailed geological mapping in scales M 1: 500 and M 1: 2 000
- Analysis of structure, orientation and kinematics of the fault system
- Analysis of contacts and shape of intrusions
- Palaeostress analysis

RESEARCH PROBLEMS

- Structure, orientation and kinematics of brittle fault systems
- Mechanism of magma emplacement in the brittle crust
- Sequence of deformation
- Regional and local stress field
- Tectonic evolution of investigated area

GEOLOGICAL SETTINGS - ELATSITE

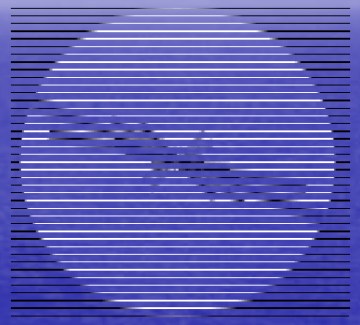


Geological sketch map of the Elatsite open pit in M 1:10 000

- Basement rocks: Paleozoic low-grade metamorphic rocks (DFC) and Variscan (314±4.8Ma) granodiorites (Vejen pluton)
- Upper Cretaceous (92-91Ma) monzodioritic to granodioritic intrusions and dykes

RESULTS
Structure, orientation and kinematics of the fault system

N



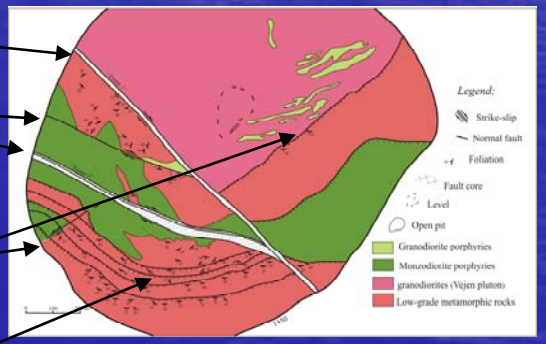
4 MAIN FAULT GROUPS:

1) NW-SE group – dextral strike-slip;

2) WNW-ESE group – dextral strike-slip;

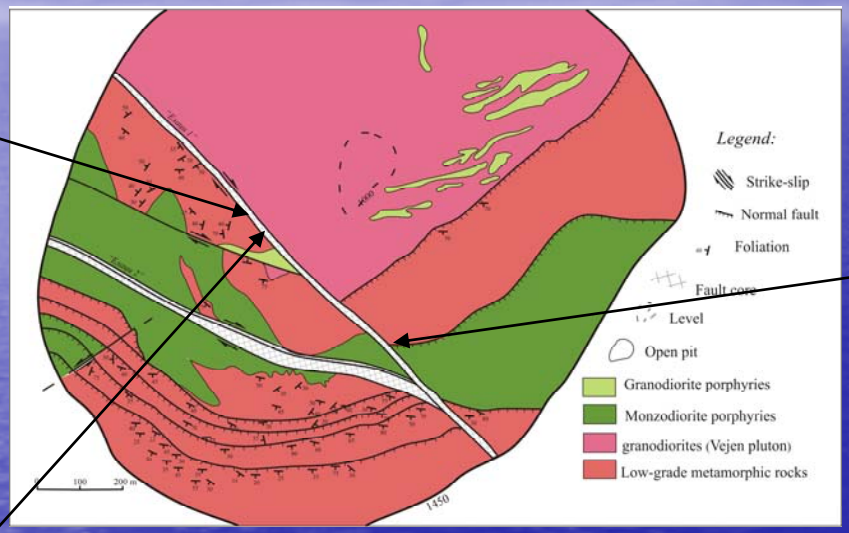
3) NE-SW group – sinistral strike-slip;

4) GENTLE DIPPING group – reverse and normal.

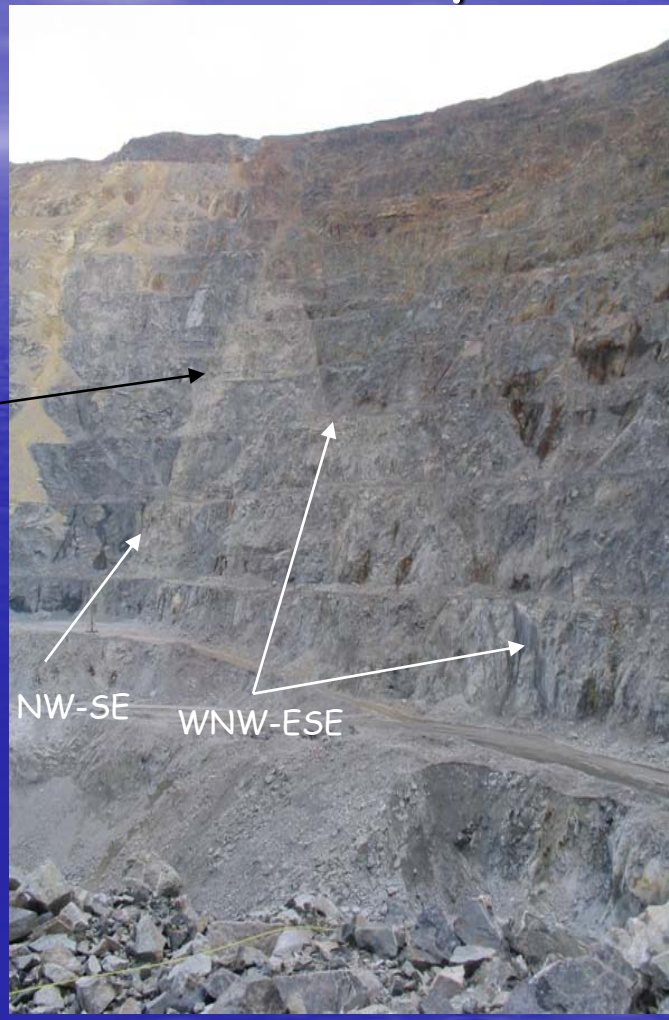


1) NW-SE (Elatsi-1) group – dextral strike-slip;

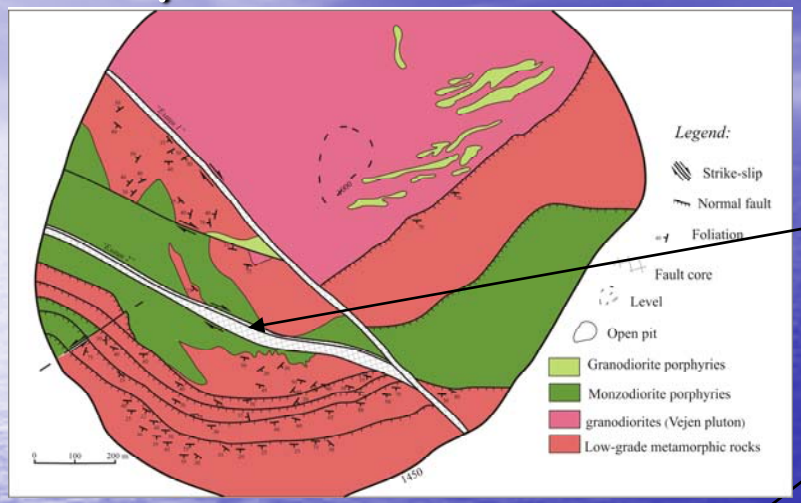
Elatsite open pit

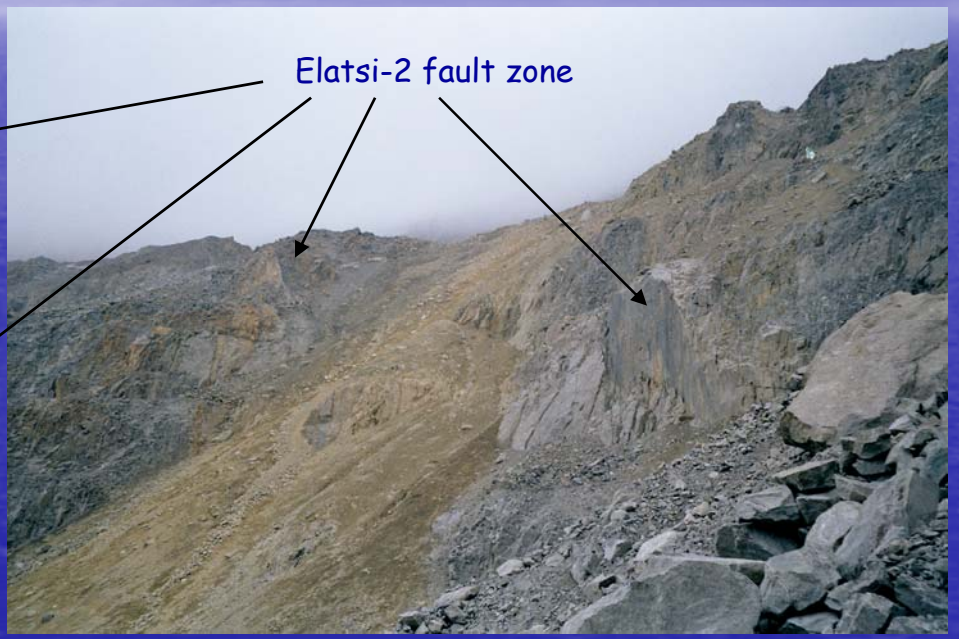


Relationships between NW-SE striking fault and WNW-ESE striking fault



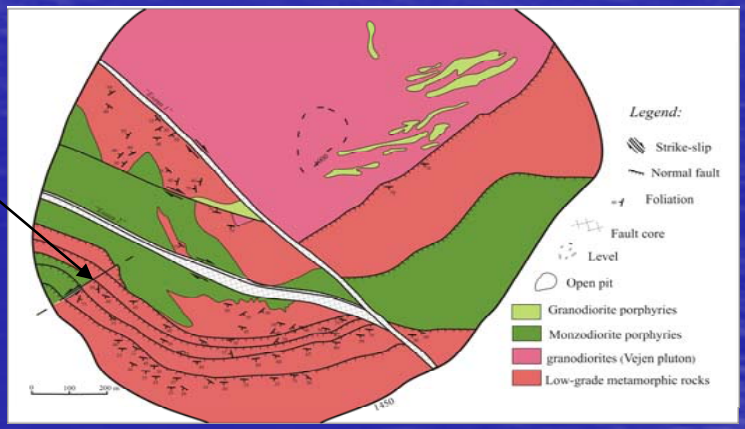
2) WNW-ESE (Elatsi-2) group – dextral strike-slip;



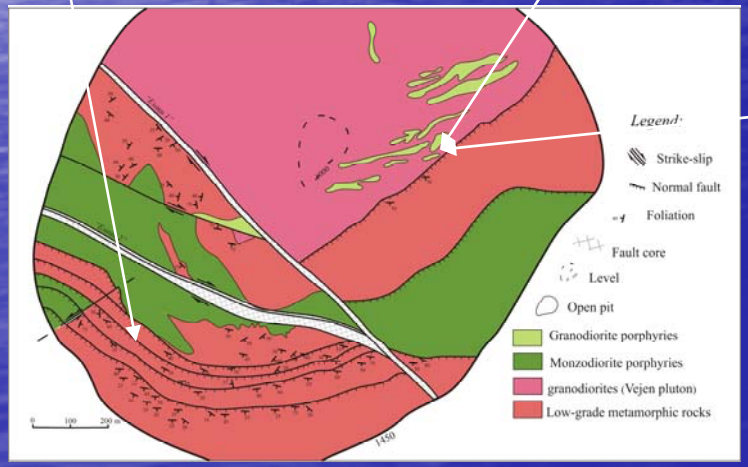


3) NE-SW group – sinistral strike-slip;

Damage fault zone



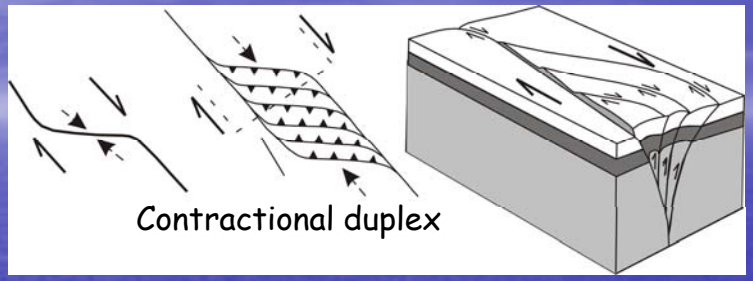
4) GENTLE DIPPING – reverse and normal faults



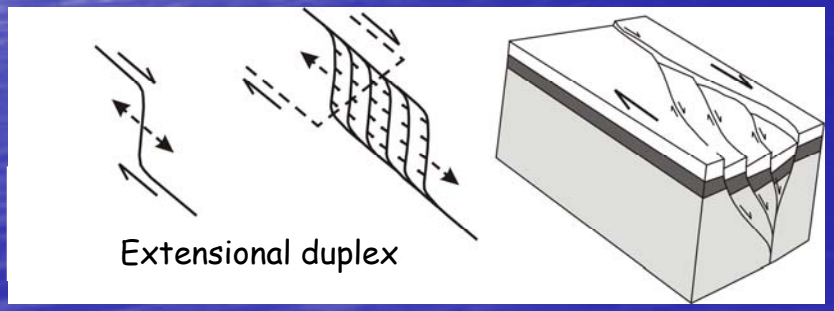
Structure of the damage zone of the brittle faults

In cross-section

Vein-hosted faults
negative "flower structure"



Displacement of Mz-Di-porf vein
Positive "flower structure"



CONCLUSIONS
Structure of the fault system

1. NW-SE-striking dextral strike-slip brittle shear zone.
2. Shear zone is composed from conjugate synthetic R (NW-SE) and P (WNW-ESE), and antithetic R' (NE-SW) shear fractures.
3. In section - every single fault group have fault core and damage zone forming "flower structure".

RESULTS
Contacts and shape of intrusions and dykes

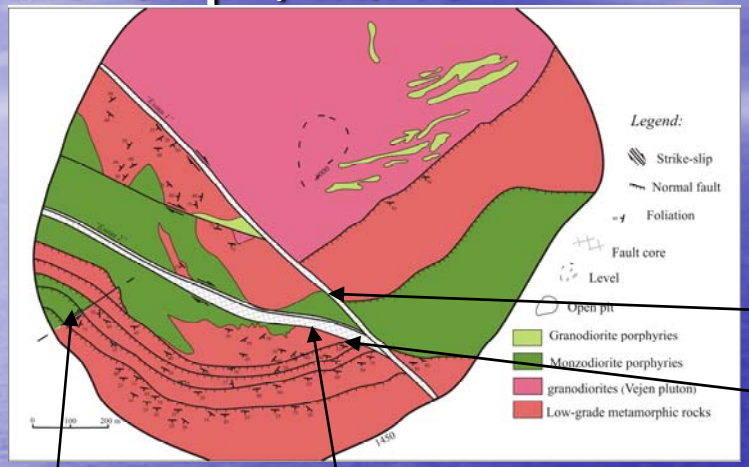
3 TYPES OF CONTACTS

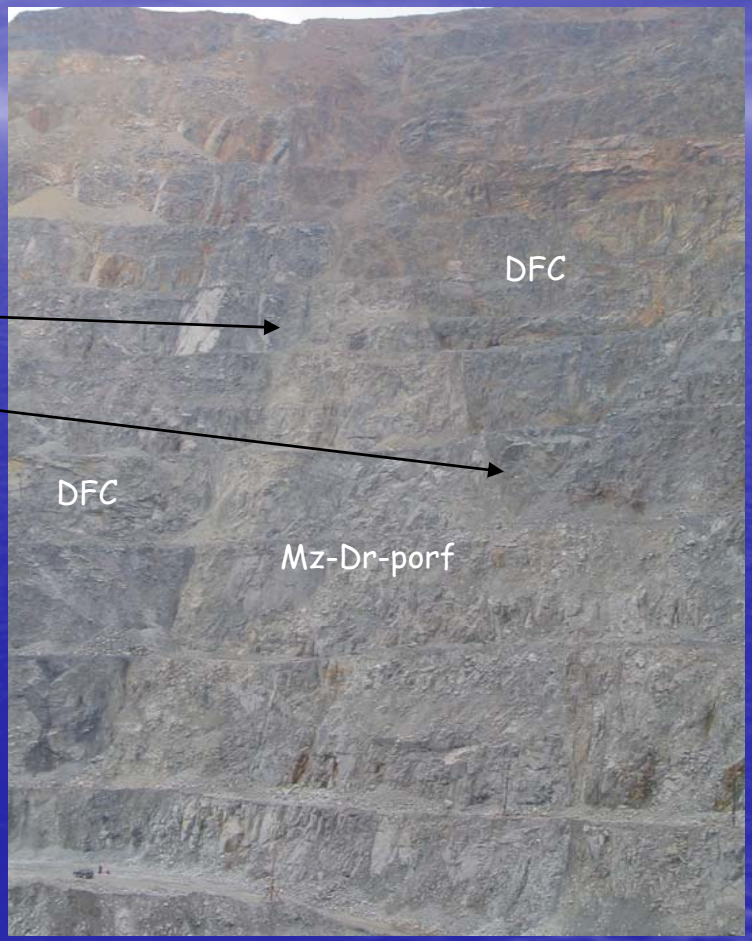
1) Sub-vertical fault contacts

2) Gently dipping (foliation-concordant) fault contacts

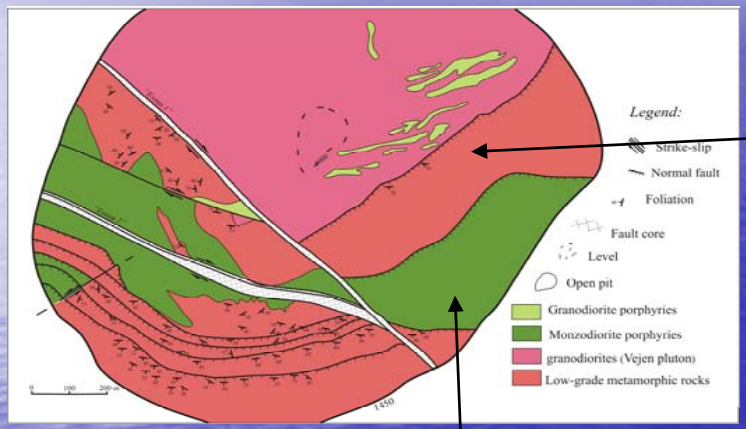
3) Intrusive contacts

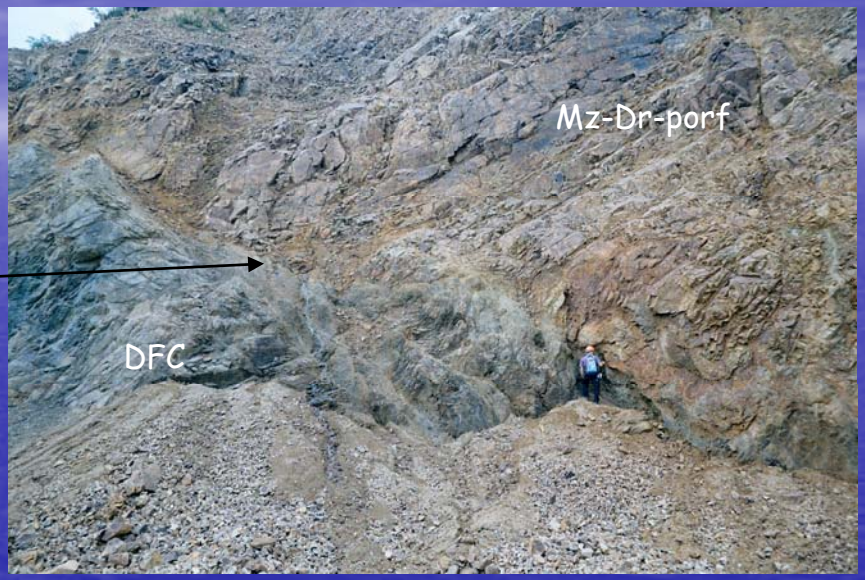
1) Sub-vertical fault contacts = main vertical strike-slip faults



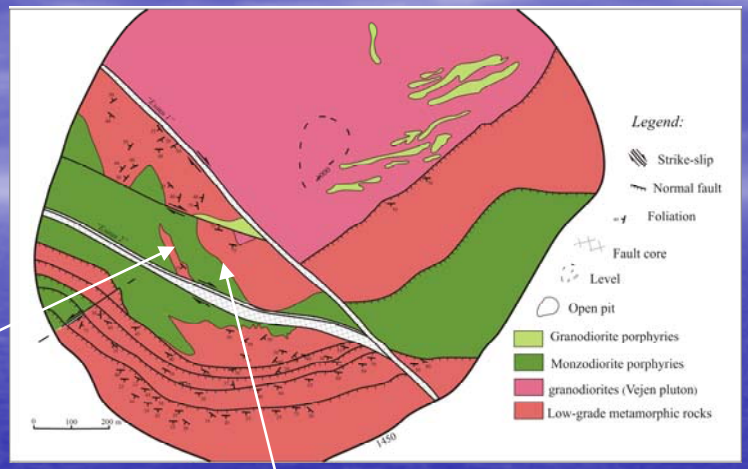


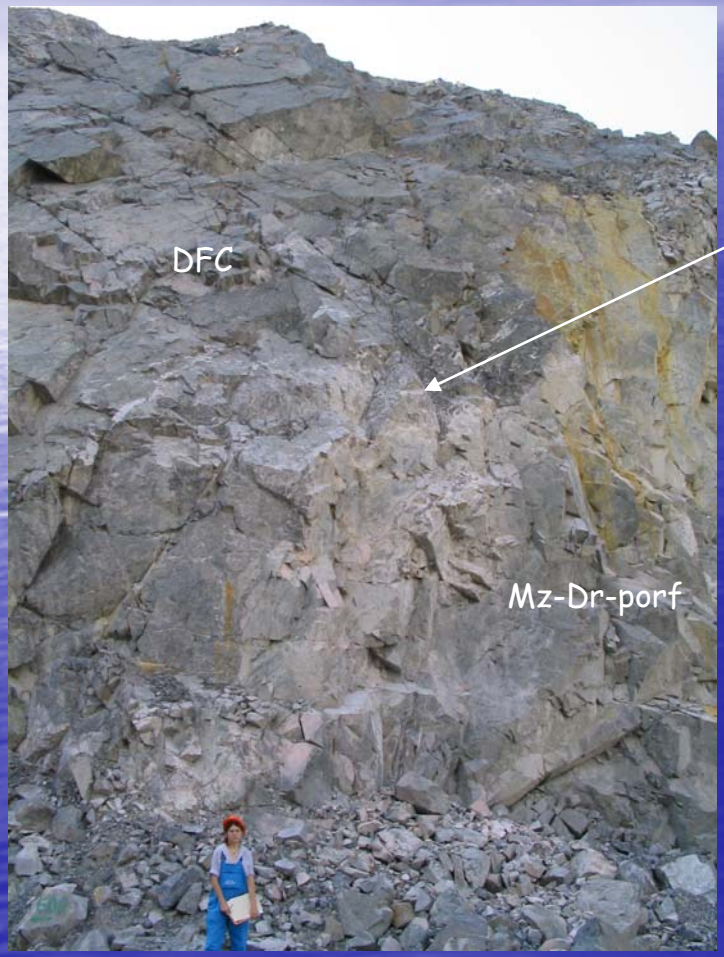
2) Gently dipping (foliation-concordant) fault contacts

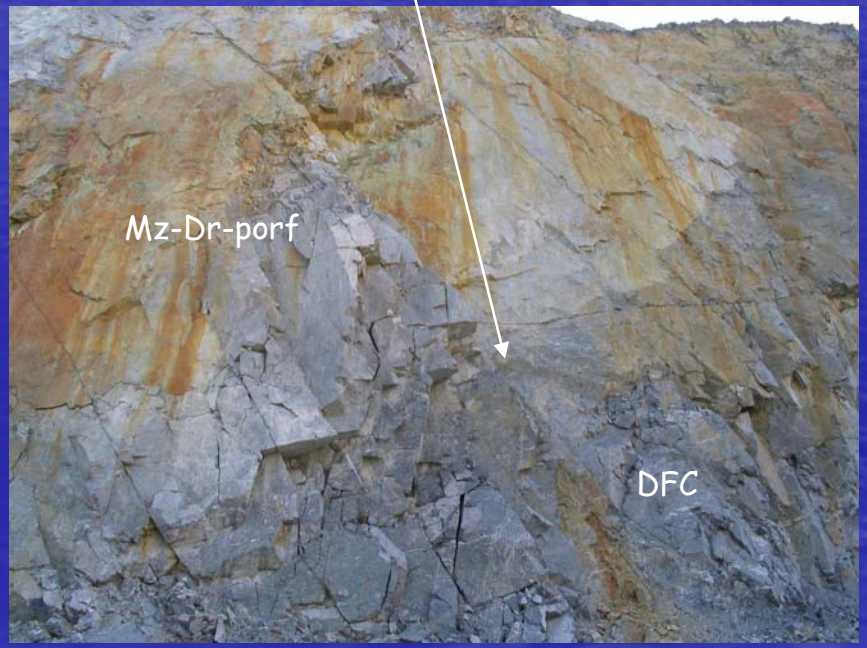




3) Intrusive contacts

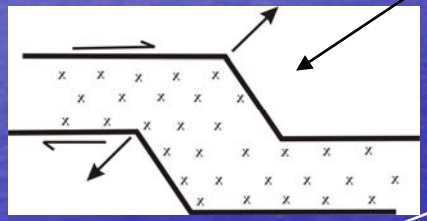


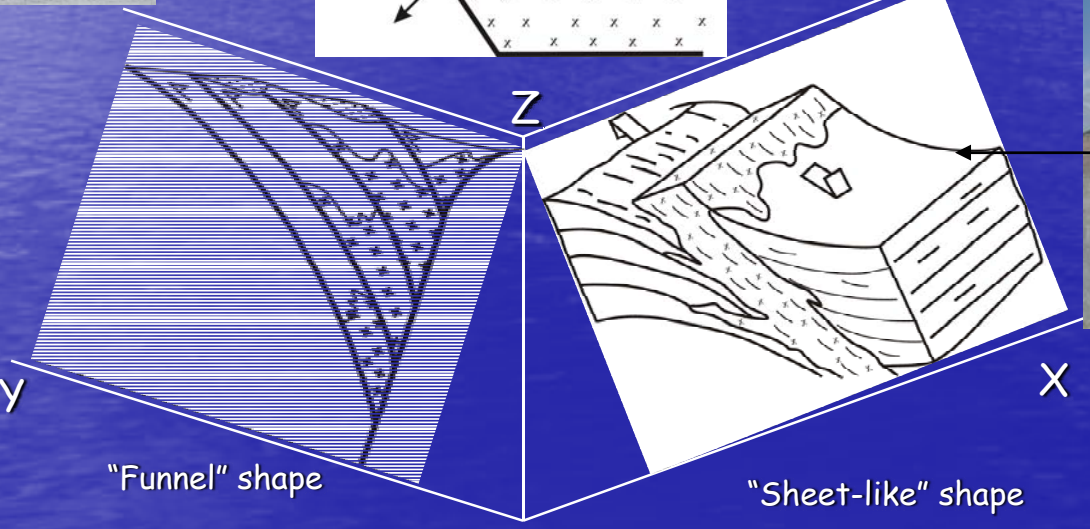




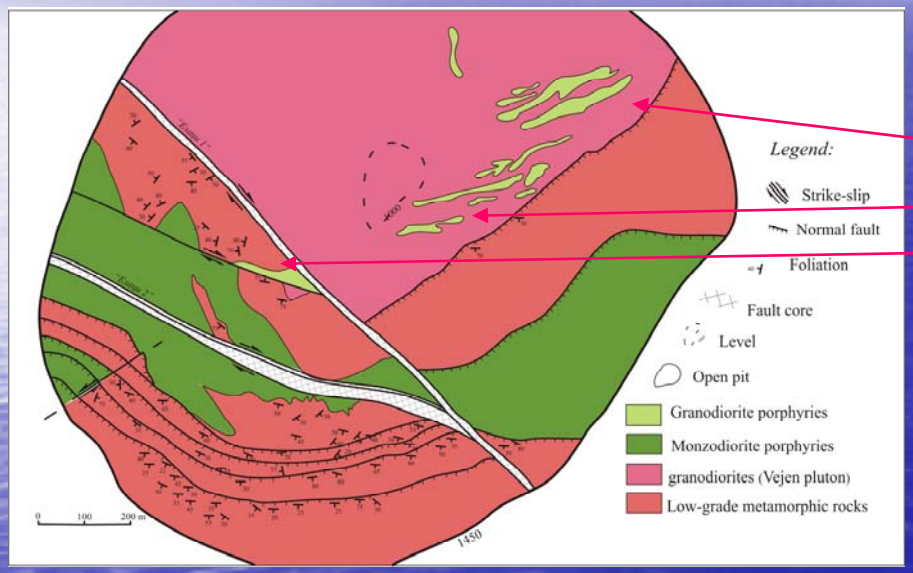
3D shape of monzodioritic intrusions

Extensional fracture





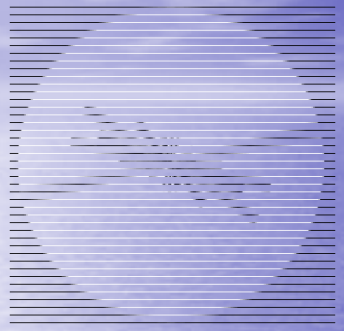
Shape of granodioritic dykes



Hydrothermal veins

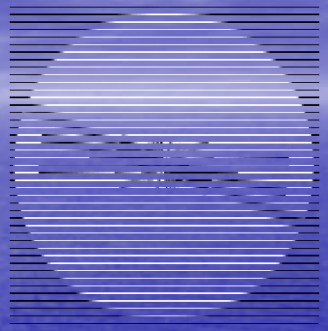
The hydrothermal veins have similar orientation and shape as faults and intrusions

Relationships between faults and veins

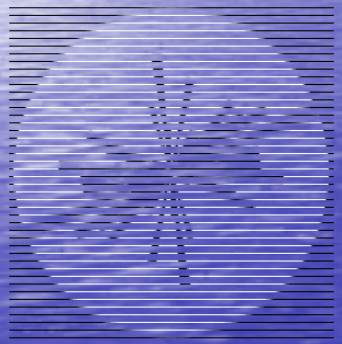


Faults - Pz granodiorites

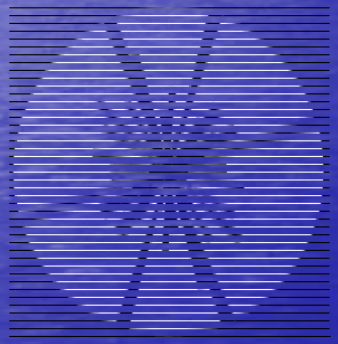
Faults - DFC



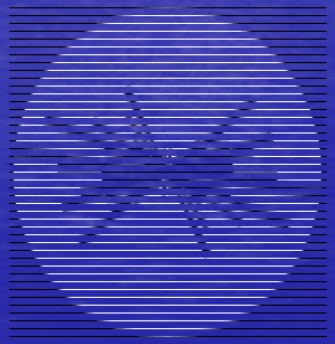
Faults - Mz-Di-porf



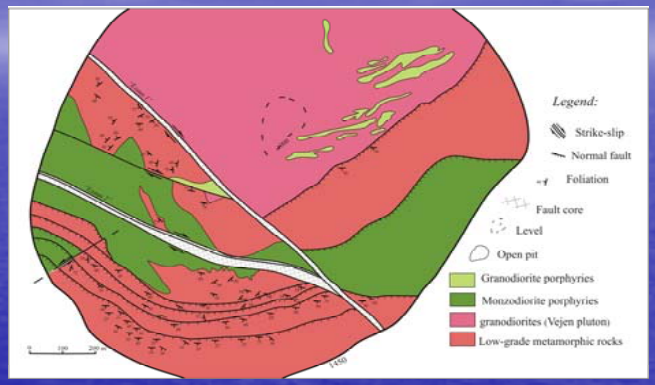
Veins – Pz granodiorites



Veins - DFC



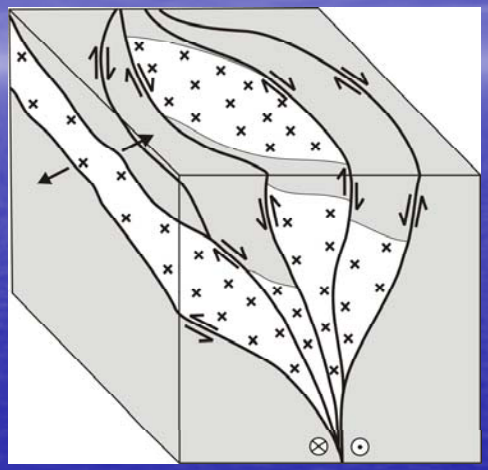
Veins – Mz-Di-porf



Strike of the faults and hydrothermal veins

CONCLUSIONS
Contacts and shape of intrusions

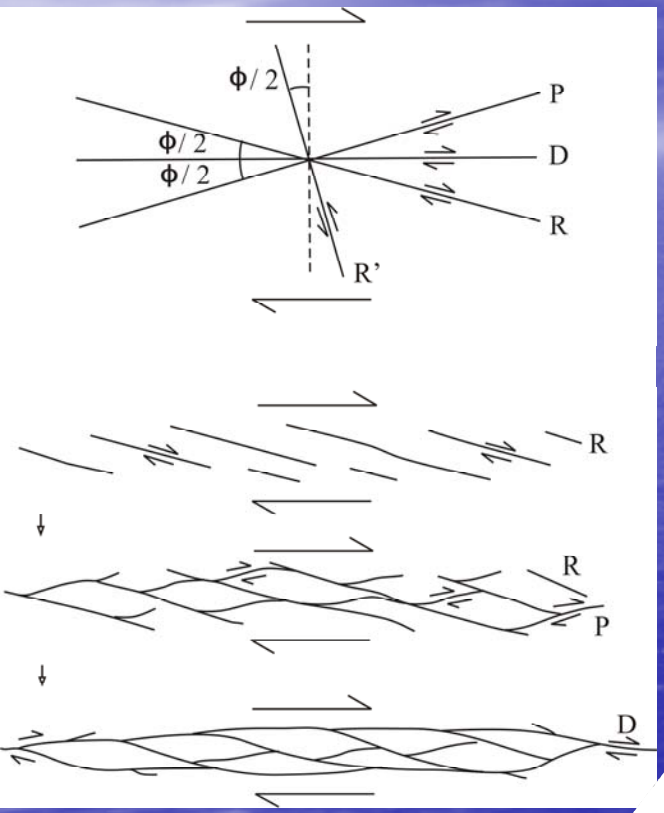
1. Orientation of contacts, shape and size of intrusions, dykes and veins are strongly controlled by complicated geometry of brittle strike-slip shear zone

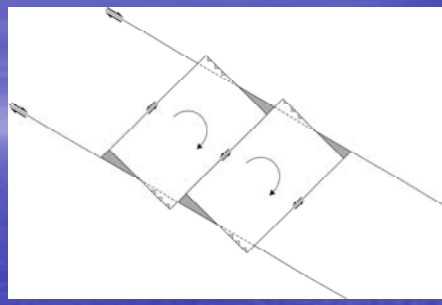


2. The intrusions, dykes and veins are emplaced into local extensional sites formed during progressive deformation of the dextral strike-slip zone

3. Emplacement is "passive" with simultaneous dilation and magma filling of the extensional structures. Intrusions were emplaced into an area of overlapping of the en echelon array of the WNW-striking (P-shears) faults. Space is created by lateral, oblique and vertical movement of the surrounding blocks in the active shear zone driven by tectonic forces

SEQUENCE OF STRIKE-SLIP DEFORMATION AND MAGMA EMPLACEMENT





1. Formation R and R'-shear fractures

2. Formation of P-shear fracture

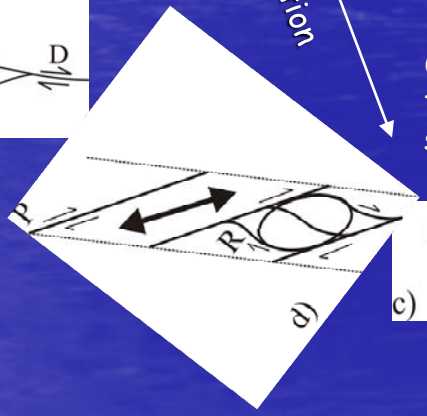
3. Formation of extensional jogs between P-shears and emplacement of monzodioritic intrusion

4. Continuous movement on the R, R' and P-shear fracture after solidification of magma

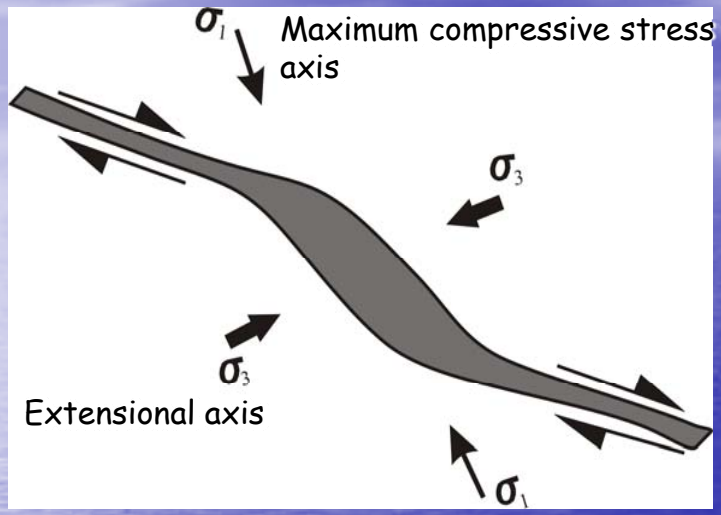
5. Rotation of the crustal blocks during progressive strike-slip deformation leading to the transformation of shear fractures in open extensional fractures with simultaneous filling with massive quartz-sulfide veins and emplacement of granodioritic dykes

6. Formation of post-mineralization shear fractures leading to disruption and displacement of magmatic-hydrothermal system

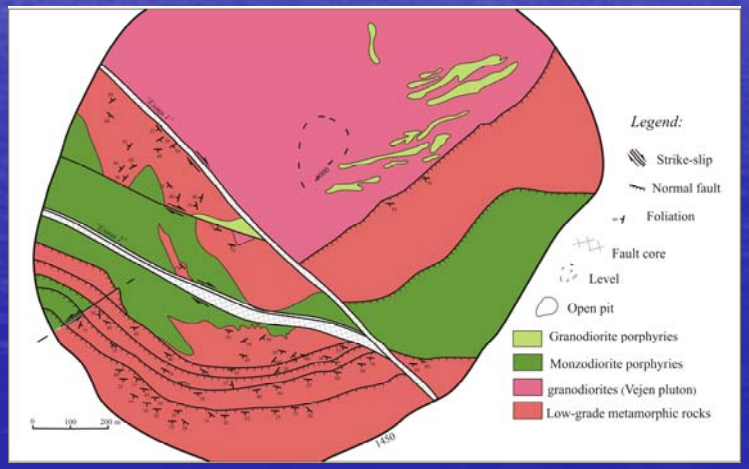
Progressive strike-slip deformation



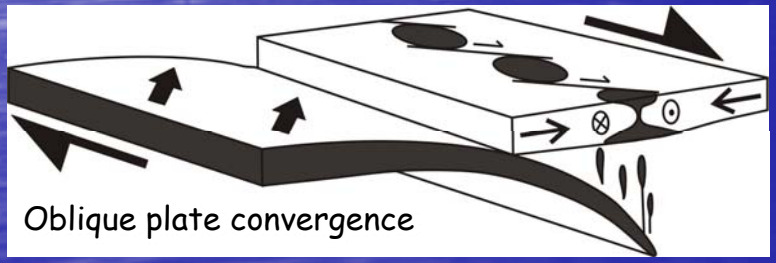
STRESS FIELD



Regionally transpressional settings with Local extensional domains formed during progressive deformation



Magma emplacement into en echelon P-shear array in transpressional plate tectonic setting



This stress field corresponds with oblique (NW-directed) subduction generated dextral strike-slip shearing

PRAVESHKA LAKAVICA DEPOSITS

Host rocks: Lower Cretaceous sediments

K2 intrusions: subvolcanic dykes and small stocks

Similar petrology and tectonic settings with Elatsite deposit

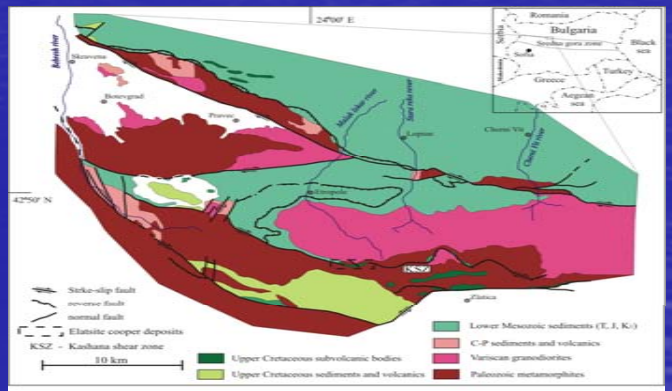
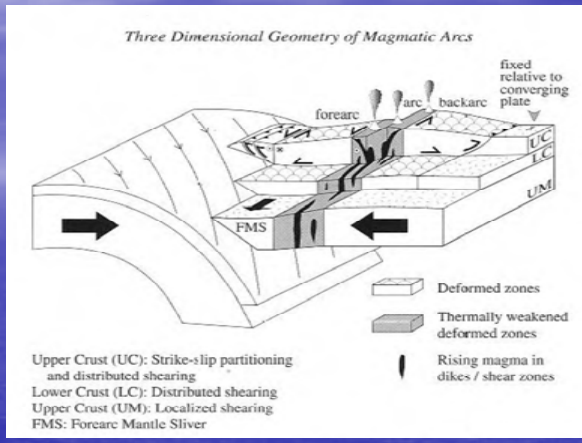


Fig. 1. Geological sketch map of the area of Etropolska Stara planina mountain (Ivanov et al., 2004) based in the geological map of Bulgaria M 1:100 000

REGIONAL TECTONIC SETTINGS AND EVOLUTION

1. D1 (the end of Early Cretaceous?) – formation of the compressional north-vergent semi-ductile Kashana shear zone and Placalnica overtrust

2. D2 (92-91Ma) – transpressional reactivation in association with magmatism and hydrothermal activity



Cratonic margins in landward or back-arc position relative to continental (Andean type) magmatic arc

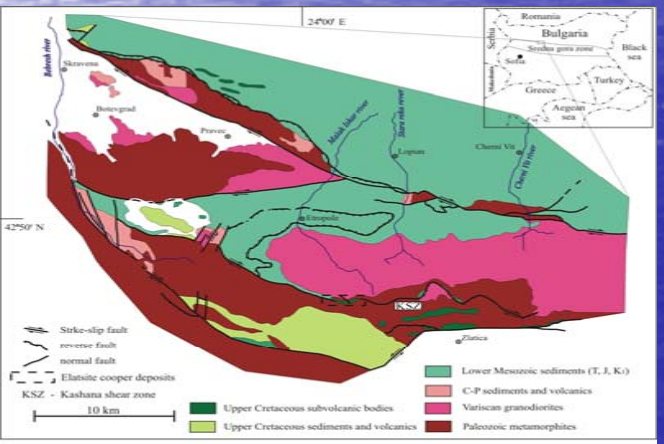


Fig. 1. Geological sketch map of the area of Etropolska Stara planina mountain (Ivanov et al., 2004) based in the geological map of Bulgaria M 1:100 000

3. D3 (92-78Ma) – initiation of major movements of the Late Alpine Srednogorie strike-slip system and formation of continental magmatic arc

THANK YOU FOR YOUR ATTENTION!