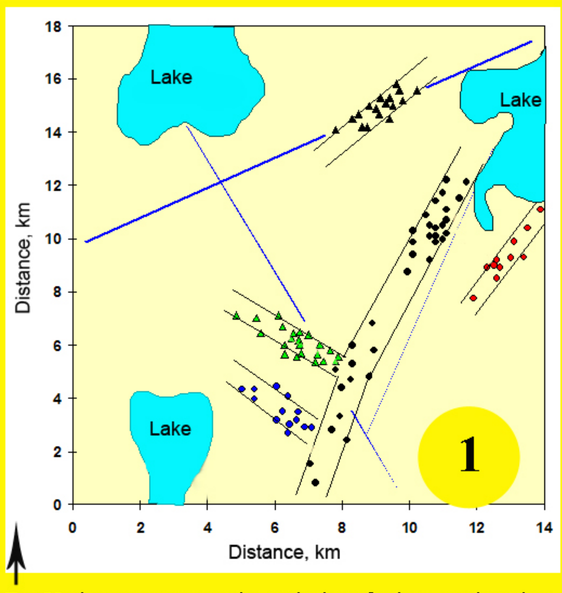
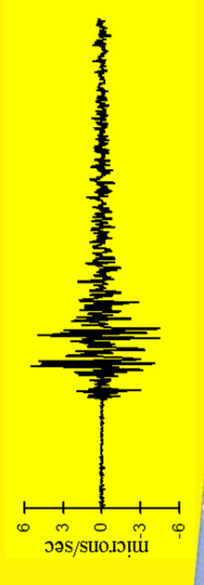
SEISMIC OBSERVATIONS OF MICRO-EATHQUAKES AT SMALL SCALE FRACTURES

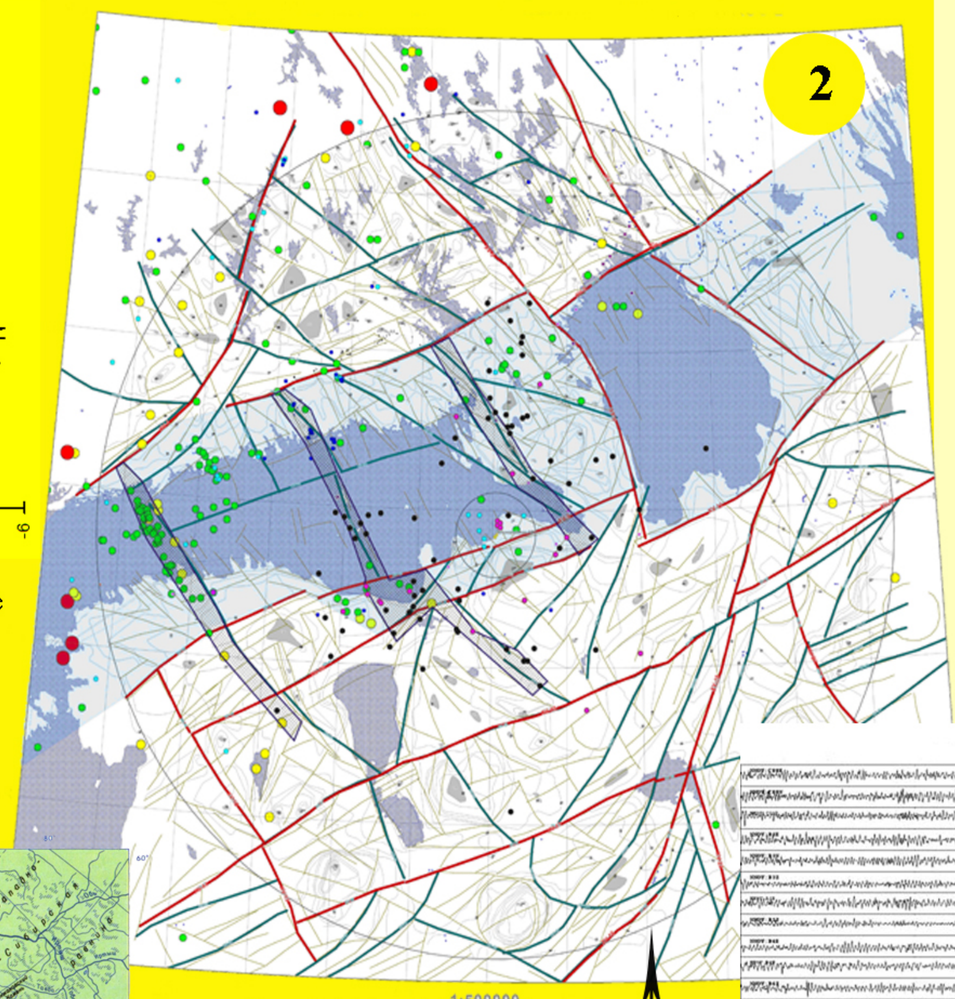
Kishkina S,
Institute of Dynamics of Geospheres Russian Academy of Science, Moscow

Spatial distribution for micro-earthquakes events recorded in the Ural and in the Karelian isthmus





For Ural measurements the majority of micro-earthquakes (M up to 2) locate the generalize fault along either. And some of the micro-earthquakes occur at feathering fractures placed at an angle to the fault line. However, the precise location of small events in the areas with thick sedimentation masses under a significant anthropogenic bondage is complicated. This reason and usage of insufficient density lineaments maps obscure the fact that small earthquakes is associated with fault zones or small scale fractures.



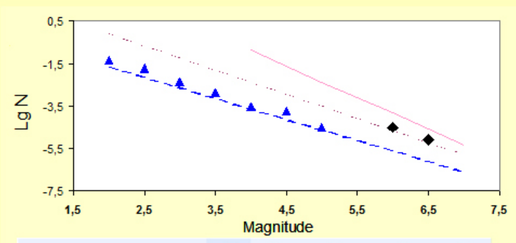
Green, yellow, red, blue circles are the epicenters of historical earthquakes [Shvarev, 2008]. Black circles are micro-eathquekes (M up to 0.3).

Localization of small events is controlled by the zone of dynamic effect of transversal zones of stress concentration; the points of intersection of transversal zones with marginal faults of the Ladoga-Baltic zone (2) of lowering are the knots of highest concentration of the epicenters of small seismic events.

Location of variety scales earthquakes on fault zones is more distinct in cases with more accurately hypocenters determined. At the same time branched structures of major fault zones, it is assumed that some of the earthquakes occur at feathering fractures of smaller scale. It is thus possible to develop a "seismological" criterion for definition of a zone of "dynamic influence of faults", i.e. the zone containing the majority of earthquakes associated with the fault zone under consideration [Kocharyan et all, 2011].

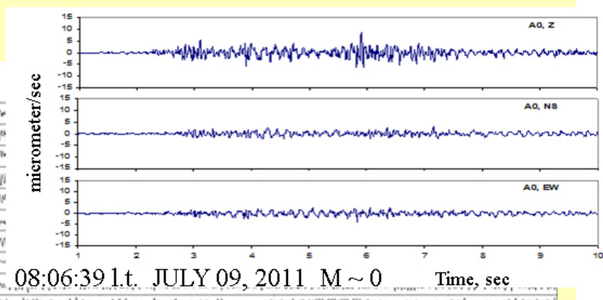
http://gt.crust.irk.ru/images/upload/tblarticle26/magazin26.pdf

Basing on historical and paleo-seismological data of previous works estimations have been made of the main parameters of events expected



Magnitude	-1	0	1	2	3
Quantity of events (30 km around zone)	63	6	1		
Quantity of events (300 km around zone)				13	1

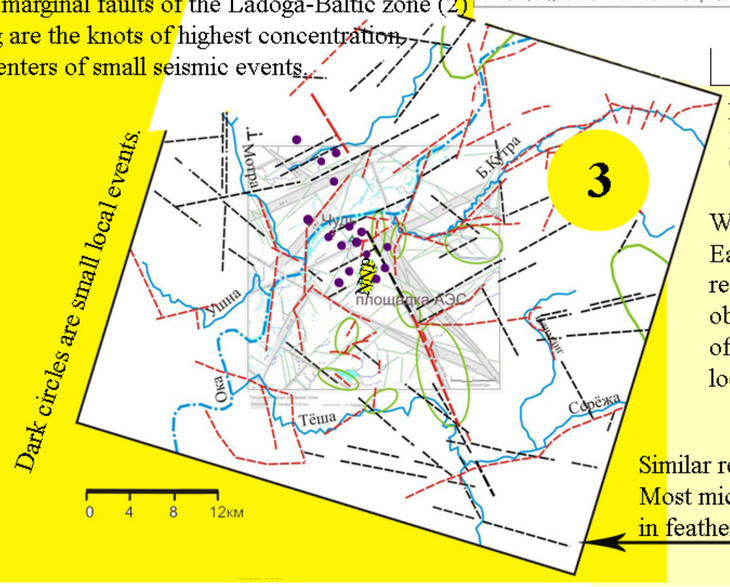
The frequency band of signals that should be registered by the system of seismic monitoring is from 0.5-1 Hz to 20-30 Hz. As far as local signals are considered, the most probable events for the territory under control are expected to have magnitudes from 0 (about 6 events a year) to -1 (63 events a year).



09:19:48.6 l.t. JULY 15, 2011 M ~ -0,5

10 sec

Examples of local seismic events for East-European Craton (Volga region).
Region with thick sediments & high anthropogenic activity



Due to the extremely difficult identification of the first arrivals of longitudinal waves, can cause errors in determining the subsequent phases. This, in turn, determine the source of the erroneous location.

We used small-aperture arrays measurements from a various points at East-European Craton and Ural. We compare the seismic data processing results and regularities revealed during the analyses with the data obtained from geomorphology studies (or satellite image interpretation) of fault structures. The results confirm most small and micro-earthquakes locate in the fault zones and zones of "dynamic influence of faults".

Similar results are obtained for aseismic Volga-region (3).
Most micro-earthquakes (M up to -1) are locate in the fault zone and in feathering fractures of smaller scale.

SEISMIC PICTURE OF A FAULT ZONE. WHAT CAN BE GAINED FROM THE ANALYSIS OF FINE PATTERNS OF SPATIAL DISTRIBUTION OF WEAK EARTHQUAKE CENTERS? (G. G. Kocharyan, S. B. Kishkina, A. A. Ostapchuk, 2011)

The common scene is more clear in case data from the most comprehensive seismic catalog such as earthquakes catalog generated at the Northern California Seismic Network are used
[**Waldhauser, F. and D.P. Schaff.** Large-scale relocation of two decades of Northern California seismicity using cross-correlation and double-difference methods // J. Geophys. Res. – 2008. – Vol. 113].
We use such precisions catalogs to make a 3D-model that shows an image of great number of earthquakes sources compared to the sharp surface. It's a conditional fault surface.

Locations of earthquake hypocenters in the vicinity of the Calaveras Fault. a – all events, b – events with M>2; c – events with M>3. Red circles show earthquakes with M>4. The larger circles correspond to events with higher magnitudes. The star shows the hypocenter of the M=6.2 earthquake. The straight line shows the conventional area of events' localization

The fault lines mapped at the surface seems to be widening due to not-vertical fault surface orientations and due to local destruction areas close to general line and containing small sources is available.

Association of earthquake hypocenters with fault zones appears more pronounced in cases with more accurately determined positions of the earthquakes. For complex, branched structures of major fault zones, it is assumed that some of the earthquakes occur at feathering fractures of smaller scale. It is thus possible to develop a «seismological» criterion for definition of a zone of dynamic influence of faults, i.e. the zone containing the majority of earthquakes associated with the fault zone under consideration.
Based on the data from a very dense network of digital seismic stations installed in this region and with application of modern data processing methods, differential coordinates of microearthquakes can be determined with errors of about first dozens of meters. It is thus possible to precisely detect boundaries of the areas wherein active deformation processes occur and to reveal spatial patterns of seismic event localization.
In our analyses, data from the most comprehensive seismic catalog were used. The catalogue includes information on events which occurred and were registered in North California in the period between January 1984 and May 2003. The seismic data processing results and regularities revealed during the analyses are compared with the data obtained from studies of fault structures, modeling and numerical simulation results. Results of quantitative research of regularities of localization of seismic sources inside fault zones are presented. It is demonstrated by 3D models that seismic events are localized in the vicinity of an almost plain surface with a nearly constant angle of dip, the majority of events being concentrated at that conventional surface. Detection of typical scopes of seismicity localization may prove critical for solution of problems of technogenic impact on fault zones for the purpose of partial stress release. The obtained results suggest that the region, wherein active deformation takes place during preparation of medium earthquakes (M≤6.5÷7.0), includes a number of local «strips», each about 100 m in width. The latter size is comparable to a scope of technogenic capabilities of producing an impact on geo-environment.
It is hoped that studies of both fine spatial and temporal patterns of seismicity in the vicinity of fault zones will allow to find reliable pinpoints for definition of both place and time for implementation of technogenic impacts.