GEODYNAMIC BACKGROUND OF EARTHQUAKE PREDICTION

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New possibilities for earthquake prediction are opened by integration of: (i) the relevant know-how developed in structural geology and geological prospecting; (ii) new data bases; (iii) theoretical models of the dynamics of blocks&faults systems. These possibilities are the following:

• *Mapping the structures where strong earthquakes and slow destructive movements are nucleated*. Those are the nodes - hierarchical mosaic structures formed around the faults' intersections (Gelfand et al 1976; Alekseevskaya et al 1977; Gabrielov et al 1996). An example is given in Fig. 1. It shows for California the map of nodes where (and only where) the epicenters of earthquakes with magnitude 6.5 or more may be situated. Identification of these nodes is based on pattern recognition analysis of geological and geomorphological data, satellite observations included. This map was published in 1976 (Gelfand et al 1976). We see that subsequent earthquakes validate identification of nodes, though it is subject to some errors.

Many such nodes harbor megacities, nuclear power plants, nuclear waste depositories and other objects for which the risk of geological disasters is unacceptable. This includes platform areas, for which such risk was just recently recognized. The nodes are well known in structural geology, geological prospecting, but often overlooked in the studies of seismicity, except pioneering studies (McKenzie and Morgan 1969; King 1986).

• *Mapping the faults' system, nodes included*, by integrated analysis of the relevant data: satellite observations, tectonic history from Precambrian to Holocene, geological, geophysical and geomorphological maps. Application of such an approach allowed to detect many previously unknown faults, also validated by subsequent earthquakes or by new geological data. More faults imply more nodes and, accordingly, more unstable areas. New data bases, particularly GPS and GIS, and recently available methods of scene recognition from space, allow much more detailed and faster analysis of such kind.

• *Mapping of nodes and faults in the platforms*, by similar methodologies. Pre-cambrian faults happen to be particularly important for that purpose. Such a mapping leads to conclusion that the rare but devastating earthquakes (like the New Madrid series in American Midwest, 1811, 1812) may occur in many more areas on the platforms, than it is commonly recognized.

• *Determination of a quantitative measure of instability of the faults system*, controlled by the nodes and monitoring its temporal changes, the approach of a strong earthquake possibly included (Gabrielov et al 1996). This measure, named *geometric incompatibility*, depicts the tendency of a fault system to stress and strain accumulation, fracturing, and change of the faults' geometry. It integrates the data on the movement in different time scales, from seismicity to neotectonics.

• *Introduction of fault system geometry into formulation of earthquake precursors*. Discussion for integration of data on seismicity, fluid regime, geochemistry, and GPS. This opens a promise for development of a next generation of earthquake prediction algorithms, short-term prediction included.

• *Study of seismicity yields in turn important information on the dynamics of lithoshpere* (Soloviev et al 1999; Rundquist and Soloviev 1999). Specific examples include: reconstruction of tectonic driving forces from territorial distribution of seismicity (Fig. 2, after (Soloviev et al 1999)); establishment of long-range interaction in the lithospheric blocks&faults system; applications to geological prospecting.

Those are the parts of a broader issue: emergence of the newly integrated geodynamics succeeding the plate tectonics. It will extend to prediction and control of geological disasters and, on another side of the spectrum, will be linked with the study of a wide class of other critical phenomena in nature and society.

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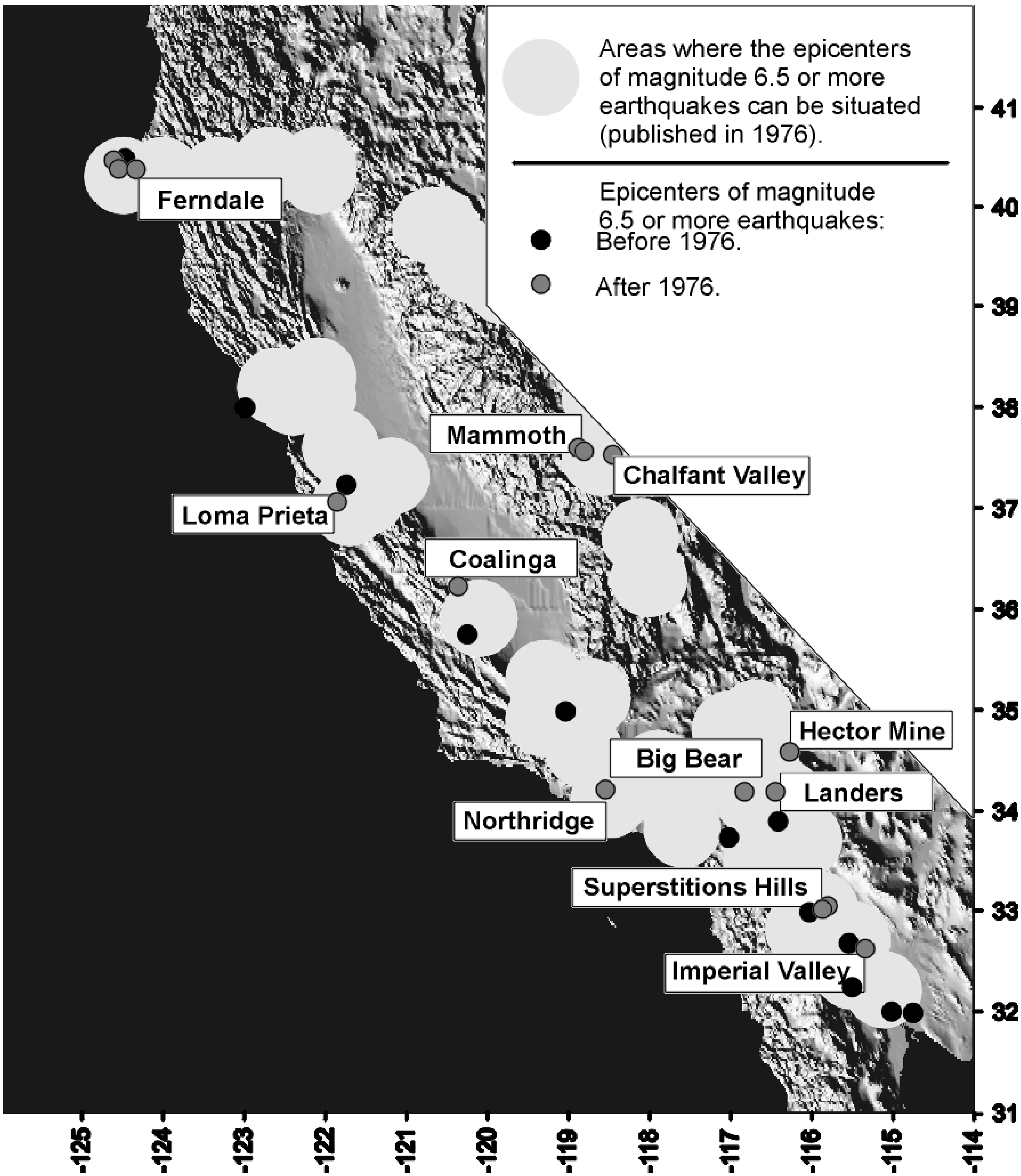

Figure 1. Recognition of areas where epicenters of strong earthquakes, M≥6.5, can be situated.

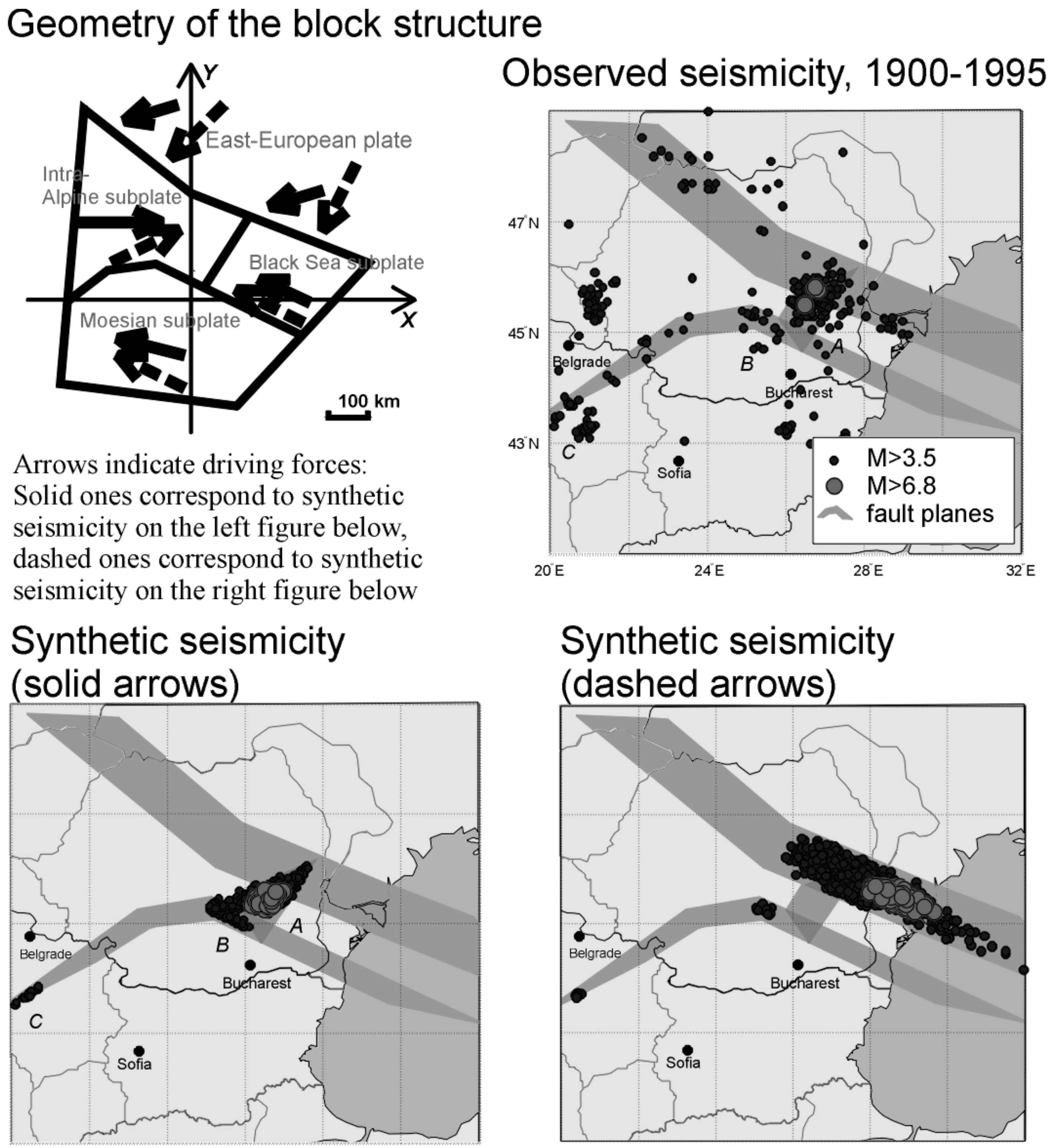

Figure 2. Reconstruction of driving forces from spatial distribution of seismicity:
model of the Vrancea region.