IN SITU MONITORING OF LOCAL SEISMICITY

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Sponsored by The Defense Threat Reduction Agency
Arms Control Technology Division
Nuclear Treaties Branch

Contract No. DSWA 01-98-C-0159

ABSTRACT

An essential element of CTBT IMS monitoring is accurate epicenter locations. Recently, focus is on the IASPEI 1991 travel time tables that are not adequate for global usage due to strong upper mantle velocity variations in many regions. Related problems are network configurations (too few reporting stations) and persistent identification and pickings of secondary phases. For small array records, phase velocities can be estimated via f-k analysis but still differentiation between Pg-, PmP- and Pn-phases and likewise Sn- and Lg-phases remain problematic. In the latter case, the issue is whether ray theory is adequate for describing wave propagation in the crustal wave guide.

We are considering two approaches to the above problems; namely i) to analyze existing monitoring performances using NORSAR GBF-bulletin data and ii) use of close-in station records from the Khibiny mining area. The GFB data cover 1999 and the total no of events were 7793 mainly stemming from Kiruna, Sweden (3544), Khibiny, Kola (956) and Zapoljarnyy, Kola (325). To our surprise, there is no strong correlation between event occurrences and time-of-day nor day-of-week. The only exception here is Kiruna with a strong concentration of explosions at midnight hours. By taking first and second order derivatives of spatial histograms (seismicity plot) it is easy to identify the above mining areas particularly through the curvature plot. The events areal coverage for the respective mining areas amount to an aperture about 1^{o} so accuracy is not unreasonable since bulletin production is automated. However, the strongest curvature are found for areas close to specific mine locations so we test this concept on other parts of Fennoscandia in order to locate the many quarries in industrialized areas. Simply, delete events in areas exhibiting small curvature. We would also see if we can outline active faults better using this procedure and the earthquake occurrences. A close scrutiny of some Khibiny mine explosions comparing epicenter determinations using our new Nansen station records and the listings from the Kola Seismological Centre, Apatity gave locations difference close to 30 km in the extreme although epicenter distances were less than 60 km. In other words, travel time tables are not the lone cause of occasionally poor event locations.

An alternative to formal epicenter determination procedures is to use waveforms instead of individual P- and S-phases. We have with base in the Nansen station tried a large number of schemes using the covariance matrix based on the 3-component recordings but really have problems in consistently recognizing signals from a specific mine. This is somewhat surprising to us since in previous studies (Fedorenko et al., 1998, 1999) such schemes proved very efficient in recognizing mining explosions - hardly any failures. In the case of the Nansen records the explanation appears to be that the mining distances are less than 20 km so near-field effects are not necessarily spatial stationary. All analysis of Nansen digital records was performed in Apatity, Kola.

A puzzling feature in some of the Nansen records is that occasionally we see a very strong secondary phase tentatively interpreted as PmP or Moho reflection. We take this as an extreme realization of a probabilistic PmP-distribution that is not entirely a novel observation in seismology. For example, Haddon and Husebye (1978) reported similar extreme P-amplitude variations across the old NORSAR array. Anyway, we are now in the process of testing the above hypothesis in terms of P-wave field synthetics for a crustal model with a randomized 3-D Moho topography and deterministic free surface topography. The aim is to find a measure (higher moments) of P-wave amplitude variability without invoking a very different crustal structure whenever such effects are observed.

Key words: Epicenter location, mine explosions, waveform classifier 3-D synthetics, Moho topography, Khibiny and Kola, NW Russia.