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Assessment of Geophysical Techniques Application during CTBTO On-Site inspections using the Evaluation Matrix concept

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Application of geophysical methods to collect evidence of possible conduct of an underground nuclear explosion is an essential element of the on-site inspection (OSI) verification component of the Comprehensive Nuclear Test Ban Treaty (CTBT). As with any geophysical survey, effective use of resources during an OSI is essential. The evaluation matrix approach can be applied to both assess in a comprehensive manner the suitability of OSI techniques with respect to an ensemble of different conditions based on a specific OSI scenario (Technology Evaluation Matrix, TEM) and to estimate the technical readiness status of a specific technology (Technical Readiness Status Matrix, TRSM). Applied to the work of the OSI Division of the Provisional Secretariat of the Comprehensive Nuclear-Test Ban Treaty Organization (CTBTO), the TRSM will support policy planning and operational projects that need to be thoroughly analyzed, providing a flexible mechanism that allows for fast and rationale decision making for resource allocation; on the other hand, the TEM will improve the functionality of an OSI by providing the inspection team a reference tool for a particular OSI scenario (e.g., yield and depth of the triggering event, geology of the inspection area, possible emplacement conditions). This assessment is important because of the limited time and number of team members provided to the inspection team for the conduct of an inspection. In this work we discuss the application of the TEM concept to the set of geophysical techniques that can be applied during an OSI for two basic underground nuclear explosion (UNE) scenarios: explosions conducted in a vertical emplacement (i.e. borehole) and explosions conducted in a horizontal emplacement (i.e. tunnel). After introducing the natural and manmade signatures usually associated with an UNE and the geophysical techniques allowed by the Treaty (with imposed constraints), examples of evaluation matrices are given for each scenario. The first matrix presented evaluates the technologies according to their relevance during an OSI using the different UNE observables as defined in the scenario. A second matrix estimates the limitations and confidence of each technique for the detection of UNE signatures. The third TEM considers the operational aspects of each technique, such as resources needed (in terms of personnel and time), simplicity of deployment, logistical factors, ruggedness, etc. Finally, the impact of this TEM concept on the search logic of an on-site inspection is discussed.