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## Safeguarding Geological Repositories –R&D Contributions from the GER SP

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Germany has contributed actively to R&D related to safeguarding geological repositories since 1980, first on the national level, since 1990 also through the SAGOR (II) and ASTOR group of experts, and other German Support Programme (GER SP) tasks. While earlier studies identified issues of essential relevance (aspects of retrievability, need for Design Information Verification (DIV), definition of physical boundaries) and developed safeguards approaches for geological repositories and encapsulation plants, R&D more recently has focused on technologies for safeguarding geological repositories: i) Satellite imagery: In a joint task with the Finnish, Japanese, and Canadian SPs, the GER SP demonstrated the potential of synthetic aperture radar (SAR) data acquired by remote sensing satellites. ii) Geophysical methods: Measurement campaigns at the Gorleben exploratory mine showed the applicability of seismic and acoustic measurement methods to detect clandestine underground mining activities. Based on the results, a follow-up project is modelling the propagation of seismic waves from different sources in the salt and surrounding sediments. Another project is investigating the applicability of underground radar technology as a directive and wide ranging technology. Active radar systems could probably be used to set up a protective screen around a geological repository. iii) Autonomous navigation and localisation: The GER SP has recently started a feasibility study on simultaneous localisation and mapping (SLAM) systems for safeguards verification purposes. Results achieved during field tests have indicated several possibilities and challenges for using indoor navigation and mapping technologies in support of geological repositories safeguards. In the near future, more attention will be paid to the impacts of (geophysical) safeguards measures on the operation and long-term safety of geological repositories. The paper presents the lessons learnt from the earlier studies and gives an overview of the results and implications of recent and on-going projects for safeguarding geological repositories.

### Country or International Organization

Germany

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