

## EURAD-2 2nd wave Template #2

By submitting this proposal, you agree to the collection, storage and protection of your personal data submitted through this form. Information collected on this form is used solely for the purpose of preparing the EURAD-2 2nd wave programme. Information provided will only be accessible on a need-to-know basis. You can access your personal data, rectify it, request its deletion or exercise your right to limit the processing of your data at the following address [dpd@andra.fr](mailto:dpd@andra.fr).

|   |   |  |  |
|---|---|--|--|
| Short Acronym and full Title  | <b>R&amp;DWP6-10 GEOSCALE</b><br><br><b>GEOSPHERE MODELS AS A TOOL FOR IMPROVING CONFIDENCE IN SITE CHARACTERIZATION AND ASSESSMENT OF LONG-TERM EVOLUTION AND SAFETY</b>   |  |  |
| Type of activity  | <input checked="" type="checkbox"/> R&D   | <input type="checkbox"/> Strategic Study     |  |
| Budget estimation (total budget in M€, i.e ~ 1.5 M€)  | ~ 3 M€  | Duration of the WP (in months)               | 36   |
| Links with EURAD SRA / Roadmap Themes<br><br>(if multiple choices, indicate the primary link in bold – maximum 3) | <input type="checkbox"/> Programme Management (Theme 1)<br><input type="checkbox"/> Pre-disposal (Theme 2)<br><input type="checkbox"/> Engineered Barrier Systems (Theme 3)<br><input checked="" type="checkbox"/> <b>Geoscience (Theme 4)</b><br><input type="checkbox"/> Disposal facility design and optimisation (Theme 5)<br><input checked="" type="checkbox"/> Siting and Licensing (Theme 6)<br><input checked="" type="checkbox"/> Safety Case (Theme 7) |  |  |
| Links with EURAD SRA topics<br><br>(if multiple choices, indicate the primary link in bold – maximum 3)           | <b>4.1.1 Site descriptive model</b><br>4.4.1 Geo-datasets and conceptional models<br>6.2.2 Detailed site characterization and site confirmation   |  |  |
| SRA drivers (maximum 3)   | <input checked="" type="checkbox"/> Implementation Safety   | <input type="checkbox"/> Tailored Solutions  | <input checked="" type="checkbox"/> Scientific Insight   |
|   | <input type="checkbox"/> Innovation for Optimisation  | <input type="checkbox"/> Societal Engagement | <input checked="" type="checkbox"/> Knowledge Management |
| Objective (What) – 1 sentence   | The WP defines a generic reference site for both crystalline and clay rocks and establishes benchmarking approaches for geosphere flow and transport models to improve transparency, credibility and robustness of geosphere models in support of siting and safety case.   |  |  |

|  |  |
|--|--|
| <p>Justification: impact / innovation / added-value (Why) – bullet points or short paragraph (maximum quarter of a page)</p> | <p>The outcome of the WP will strengthen the confidence in geosphere models, increase social acceptance and transparency of repository siting procedures, and build public trust in geosphere models. The development of common synthetic reference sites as the basis for benchmarking exercises opens new opportunities for development and testing of modelling strategies and tools within the WP and beyond EURAD-2, by facilitating openness between organizations and with public. This reduces costs for all Member States through common practices in siting procedures and via enhanced safety case.</p> <p>The WP will follow a holistic approach for the development of geosphere models as a tool to improve the accuracy of long-term predictions with respect to the safety functions of the geosphere. It will contribute to</p> <ul style="list-style-type: none"> <li>• the site selection process, by e.g. offering guidance to efficient above and underground site selection strategies based on scientific, site-specific geosphere understanding, which can in return lead to a reduction of necessary drillings and hence reduce time and cost efforts.</li> <li>• the optimisation of the repository lay-out and planning approaches through a quantified contribution of the geosphere to safety functions, thus reducing safety redundancies and conservatism, increasing the understanding of risks at large scale, and describing the evolution of site-specific long-term processes.</li> </ul> <p>The outcomes of the WP will provide guidance for Member States on approaches, required datasets and workflows for quantitative modelling the long-term evolution of the geosphere with respect to flow and transport. Lessons learned from advanced programs will support Member States in the early phase of their siting processes.</p> |
| <p>List of planned tasks / subtasks with % of effort per task (5% increments) (Maximum 10 bullets)</p>                       | <p><b>Task 1 Management and coordination of the WP 10%</b></p> <p><b>Task 2 Knowledge Management 15 %</b></p> <p><b>Task 3: Geosphere functions, processes and parameters with respect to long term safety and development of generic reference sites 25%</b></p> <p>Subtask 3.1: Definition of requirements for site descriptive flow and transport models</p> <ul style="list-style-type: none"> <li>• Parameters, processes and scenarios to be considered in geosphere models (→ input for definition of benchmarks in task 4)</li> <li>• Parameters to be extracted from boreholes/ field investigations (→ input for task 5)</li> <li>• Stakeholder engagement</li> </ul> <p>Subtask 3.2: Development of generic reference sites and benchmark scenarios for flow and transport modelling</p> <ul style="list-style-type: none"> <li>• Develop generic reference sites, for clay and crystalline host rock. The options for site generation are currently evaluated: a fully synthetic site or a simplified real site (based on e.g. an abandoned investigation site, rock laboratory setting).</li> <li>• Define scenarios to be modelled, geometry and models, evaluation criteria for the benchmark study.</li> </ul> <p><b>Task 4: Development and benchmarking of modelling scenarios for geosphere evolution in crystalline and clay host rock 30%</b></p>   |

|  |  |
|--|--|
|  | <p>Subtask 4.1: Implementation and evaluation of benchmarking approaches</p> <ul style="list-style-type: none"> <li>• Implementation of changing boundary conditions to assess the long-term evolution (e.g. effect of climate change and erosion on groundwater systems and host rock, hydromechanical coupling, local flow and transport processes).</li> <li>• Testing and comparing different modelling approaches and software for the benchmarking scenarios and coupling of subsidiary models (e.g. DFN models). Optimisation of modelling scenarios for different siting purposes.</li> </ul> <p>Subtask 4.2: The evolution of site descriptive flow and transport models during progressive data generation</p> <ul style="list-style-type: none"> <li>• Development of recommendations for geosphere models with respect to various siting stages and site-specific situations.</li> <li>• Coupling of subsidiary models with respect to modelled processes, complexity, changing boundary conditions, and confidence building for different modelling scenarios.</li> </ul> <p><b>Task 5: Assessment of spatial data requirement and approaches for efficient generation of model parameters from field investigation 20%</b></p> <ul style="list-style-type: none"> <li>• Focus on local to regional scale borehole and geophysical data from both, crystalline and clay rock sites; Evaluation of minimum and extended datasets from boreholes required for parameter derivation and process understanding (based on definition of parameters defined in task 3); Statistical analysis and comparison of existing AI/machine learning tools and conventional data analysis methods for parameter extraction.</li> <li>• Sensitivity analysis and evaluation of the effect of increased input data on modelling scenarios; evaluation of requirements on spatial data density (e.g. borehole density and related key measurements, geophysical studies, geological data acquisition), and development of feedback-loops for geosphere models.</li> </ul> |
| <p>List of expected outcomes linked to the identified SRA drivers</p> <p>(Maximum 6 bullets)</p> | <p>Scientific Insight:</p> <p>Establishment/definition of generic reference sites for crystalline and clay host rock to develop know-how and tools for all Member States and projects/communities beyond EURAD-2.</p> <p>Enhance quantitative capabilities of geosphere flow and transport models with respect to implementation of boundary conditions, coupling of subsidiary and different scale models. Develop system understanding and increase confidence in the groundwater flow and transport modelling to reduce uncertainties, reduce costs, build trust for society and stakeholders.</p> <p>Recommendation of minimum and extended datasets to be generated at different siting stages, to be used in flow and transport models, and guidance how to efficiently generate and apply them.</p> <p>Implementation safety:</p> <p>Improved understanding of the geoscientific modelling process and factors affecting the confidence in the models to support site selection, site characterisation, and post-closure safety.</p>  |

|   |   |
|---|---|
|   | <p>Knowledge Management:</p> <p>Provide guidance to tailor the groundwater flow and transport modelling approaches to be suitable for the sites, considered at various national programme stages. Despite focus in the WP on the geosphere surrounding deep geological repositories, conceptual and technical advances for geosphere flow and transport models will also be beneficiary for other settings, e.g. LLW/ILW repositories at shallower depth. The WP provides high training potential and potential for exchange between member states at different stages of the siting process.</p>   |
| <p>Deliverables<br/>(Maximum 6 – including the prescribed deliverables)</p> | <p><b>D1</b> Initial State of the Art (SotA) assessment (Month 6)</p> <p><b>D2</b> Definition of requirements for site descriptive flow and transport models and of generic reference sites and benchmarking scenarios.</p> <p><b>D3</b> Final technical report on modelling scenarios based on the benchmark studies (Task 4) and comparison of techniques for the efficient evaluation of field data (Task 5)</p> <p><b>D4</b> Updated SotA with summary and recommendations</p> <p><b>D5</b> Outcome/impacts report to Member States and End Users</p>   |
| <p>Critical input requirements &amp; identified risks</p>                   | <p>Input:</p> <ul style="list-style-type: none"> <li>• Information on the modelling approaches and the models with respect to processes needed to be addressed (input from WMO, TSO and RE)</li> <li>• Definition of key processes and long-term evolution scenarios, to be considered in the model-based assessment of geosphere evolution</li> <li>• Definition of desired characteristics of the generic reference sites</li> </ul> <p>Risks:</p> <ul style="list-style-type: none"> <li>• Complexity of the reference sites to be established as it is the basis for benchmark modelling work</li> <li>• Underestimation of benchmark modelling efforts and comparison</li> </ul> |
| <p>(Optional - Explain what is out of the scope?)</p>                       | <p>Development of new ML/AI techniques<br/>Development of new reactive transport codes for geosphere models<br/>Evaporitic host rocks<br/>Radionuclide migration studies</p>  |

|  |  |
|--|--|
| <p>List of preliminary interested organisations as partners in the WP contributing effort; % of effort (person months, by College)</p> | <p><b>RE 50%</b></p> <p>Amphos 21 (ES) , CVU (CZ) , TUDELFT (NL), Galson (UK), GTK (FI), GFZ (DE), RATEN ICN (RO), IGN (CZ), ENEA (IT), LEI (LT), Clay Technology (SE), PSI (CH), SCK CEN (BE) , SIIEG NASU (UA), Tractebel-engie (BE), UFZ (DE), UKNNL (UK), UniBern (CH), UDC (ES), TUL (CZ)</p> <p><b>TSO 40%</b></p> <p>AGES (AT), ASNR (FR), Bel V (BE), CIEMAT (ES), EIMV (SI), FTMC (LT), GRS (DE), NTW (EU), VTT (FI), WSP (HU)</p> <p><b>WMO 10%</b></p> <p>BGE (DE), Nagra (CH), NES (AT), Posiva (FI), SKB (SE), Sogin (IT)</p> |
| <p>If applicable - links with previous projects / work packages</p>  | <p>EURAD-1: DONUT, FUTURE, UMAN, MODATS</p> <p>EURAD-2: RAMPEC, HERMES, CLIMATE</p> <p>EURAD-2 2<sup>nd</sup> Wave Proposal: WP AI/ML</p> <p>CROCK project, DECOVALEX, SKB Task Force</p>  |
| <p>WP Preparation Team (1 member per College) contact (organisation + person, email)</p>   | <p>Main contact in bold</p> <p>RE:<br/> <b>UniBern (CH), Mirjam Kiczka</b>, mirjam.kiczka@unibe.ch<br/>         GTK Finland (FI), Jon Engström, jon.engstrom@gtk.fi</p> <p>TSO:<br/> <b>VTT (FI), Pirjo Hellä</b>, pirjo.hella@vtt.fi<br/>         GRS (DE), Susan Britz, susan.britz@grs.de<br/>         Bel V (BE), Jeroen Mertens, jeroen.mertens@belv.be</p> <p>WMO:<br/> <b>Nagra (CH), Michael Schnellmann</b>, michael.schnellmann@nagra.ch</p>   |