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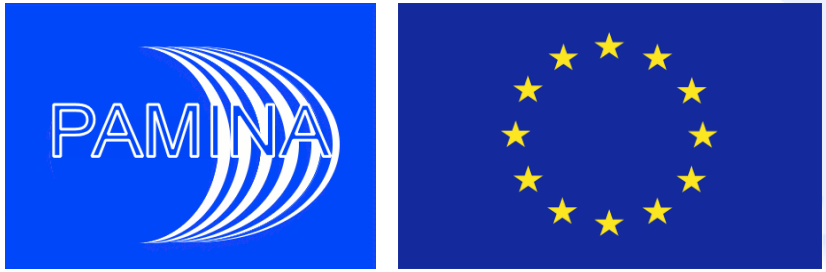

Performance Assessment Methodologies in Application to Guide the Development of the Safety Case

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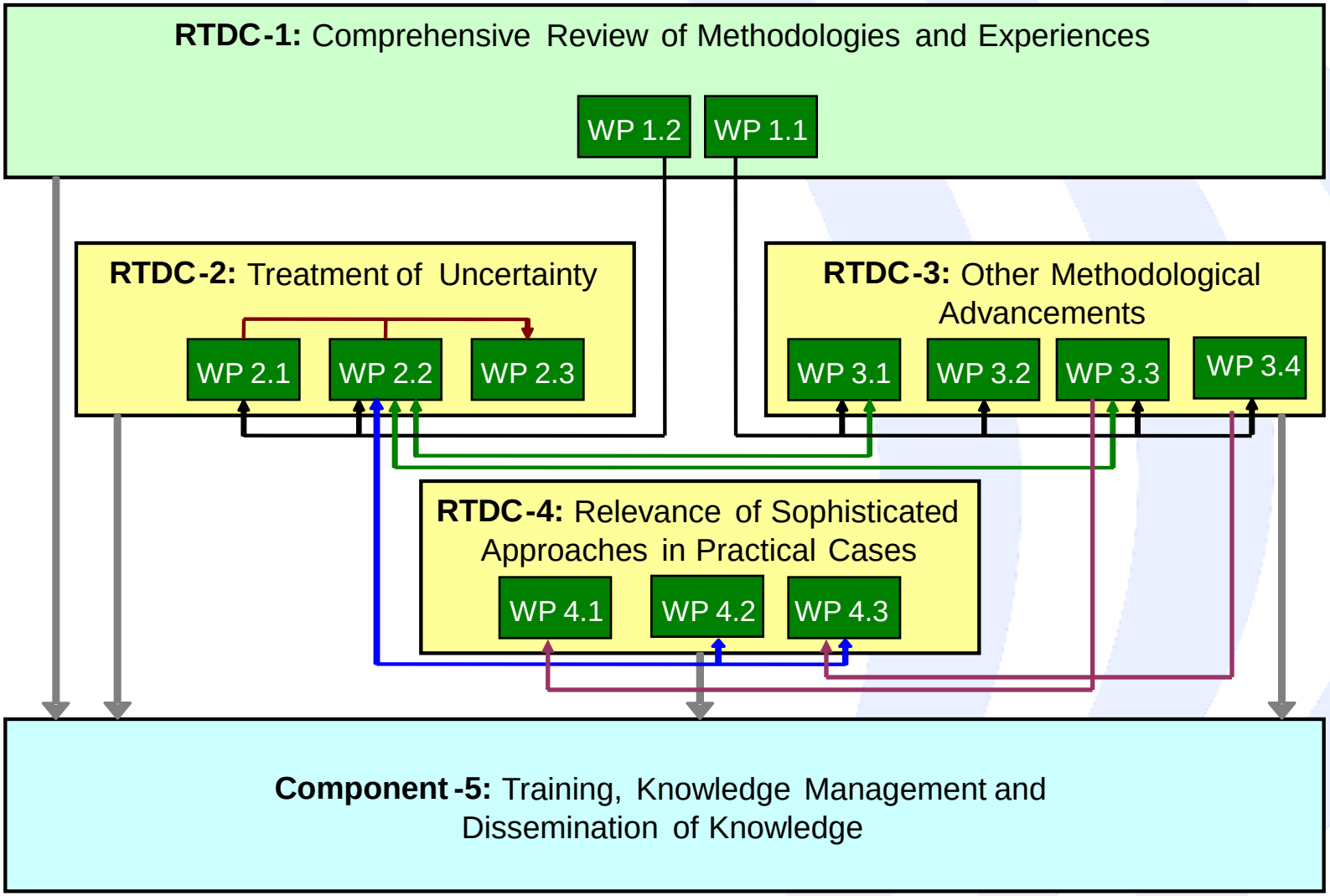
IP PAMINA – General information

- **Performance Assessment Methodologies in Application to Guide the Development of the Safety Case**
- October 1, 2006 – September 30, 2009
- www.ip-pamina.eu

- Germany: GRS, BGR, DBETec, FZK, TUC
- France: ANDRA, CEA, IRSN, Univ. Lyon
- Spain: Enresa, UPV, UDC, Amphos
- UK: NDA, Galson
- Belgium: ONDRAF, SCKCEN, BEL-V
- Switzerland: NAGRA, Colenco
- Netherlands: NRG
- Czech Republic: NRI
- Finland: Posiva, VTT
- Sweden: SSM, Facilia
- EC: JRC Petten

Work Structure



RTDC-1: Comprehensive Review

- Up-to-date **comprehensive review of SA methods, tools and experiences**
  - coverage of **European countries** and relevant programs **outside Europe**.
  - work in **international organizations** is integrated (EC-FWP, IAEA, NEA e.g. INTESC).
  - identify **shortcomings** and areas for **improvement** and **harmonization**
- 11 Topics are considered

Topics Covered

- Group 1 of topics (finished, task reports available):
  1. Safety functions
  2. Definition and assessment of scenarios
  3. Uncertainty management and uncertainty analysis
  4. Safety indicators and performance/function indicators

- Group 2 of topics (Task reports to be prepared):
  5. Safety strategy (Assessment strategy + Safety approach)
  6. Analysis of the evolution of the repository system
  7. Modeling strategy
  8. Sensitivity analysis

- Group 3 of topics (just launched):
  9. Biosphere
  10. Human intrusion
  11. Criteria for input and data selection

Review Procedure

- For each review topic, three-step approach is adopted
  - Target definition
  - Overview of methods and approaches; information is collected from different programmes in a specifically structured approach
    - from the developer‘s viewpoint
    - from a regulatory viewpoint
  - Analysis and synthesis
    - in order to formulate conclusions on the strong and weak points perceived in the methods and approaches
- Workshop for each set of topics

Review Results

The results planned are:

- One task report per topic (4 already included in D1.1.1) with:
  - the outcomes of the workshops
  - the individual contributions
- Three deliverables: one per set of topics
- The European Handbook of the state-of-the-art of safety assessments of geological repositories. The handbook is formed by:
  - the 11 task reports (revised?)
  - some additional material to assure that the text is coherent and readable. The additional material will be discussed in the 3rd WP1.1 workshop.

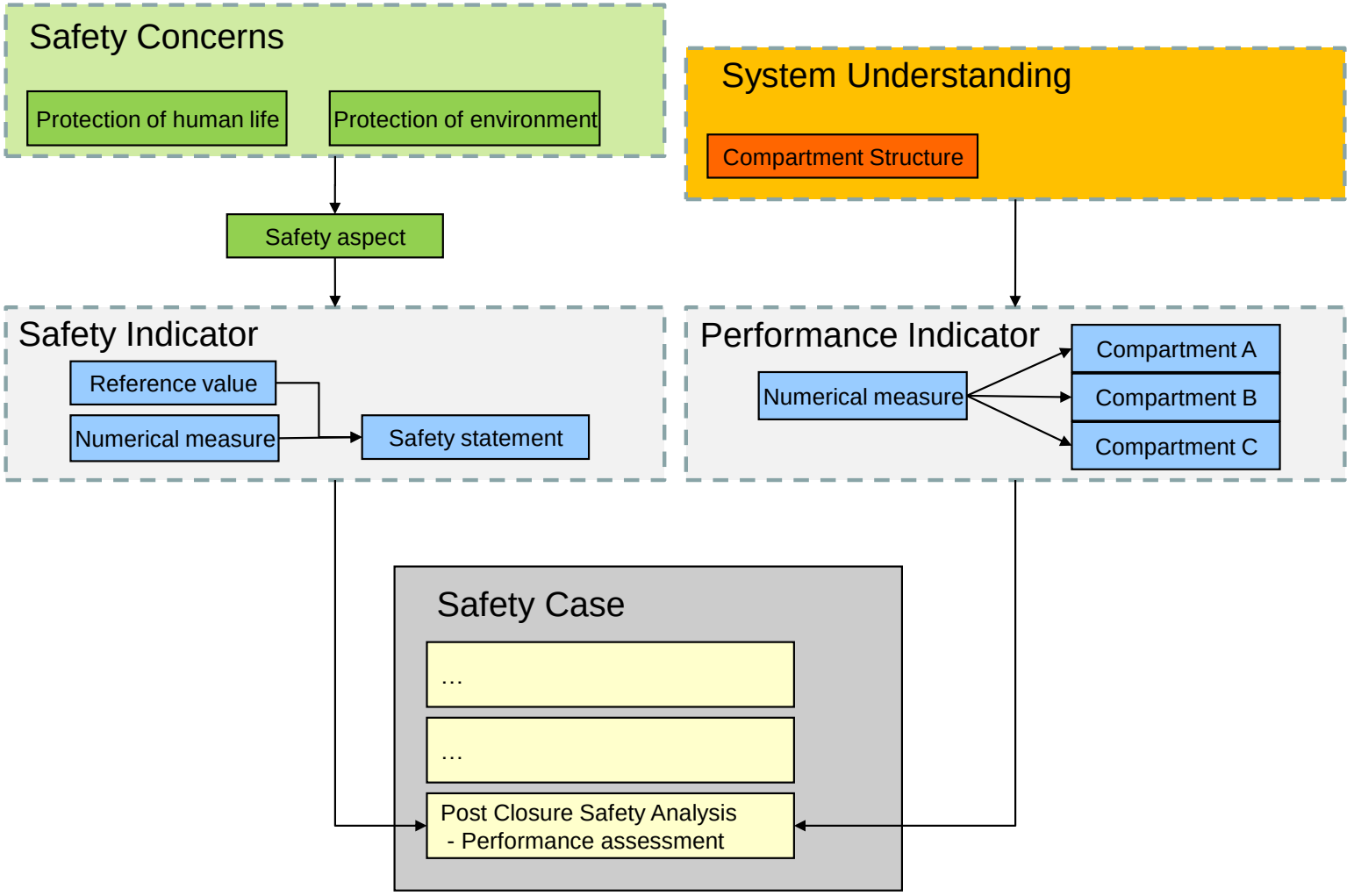
Safety Function - Conclusions

- Application of defence-in-depth principle led to the introduction of safety functions for geological disposal systems around 1995
- SFs are intensively used and play an important role in many Safety Cases since 2000
- Strong similarity in the sets of SFs derived in various national RWM programmes
  - Stability/isolation
  - Containment
  - Limited and delayed releases
- Safety demonstration of geological disposal systems is shifting from a component-based to a safety-function-based reasoning
- Various applications of SFs in recent Safety Cases

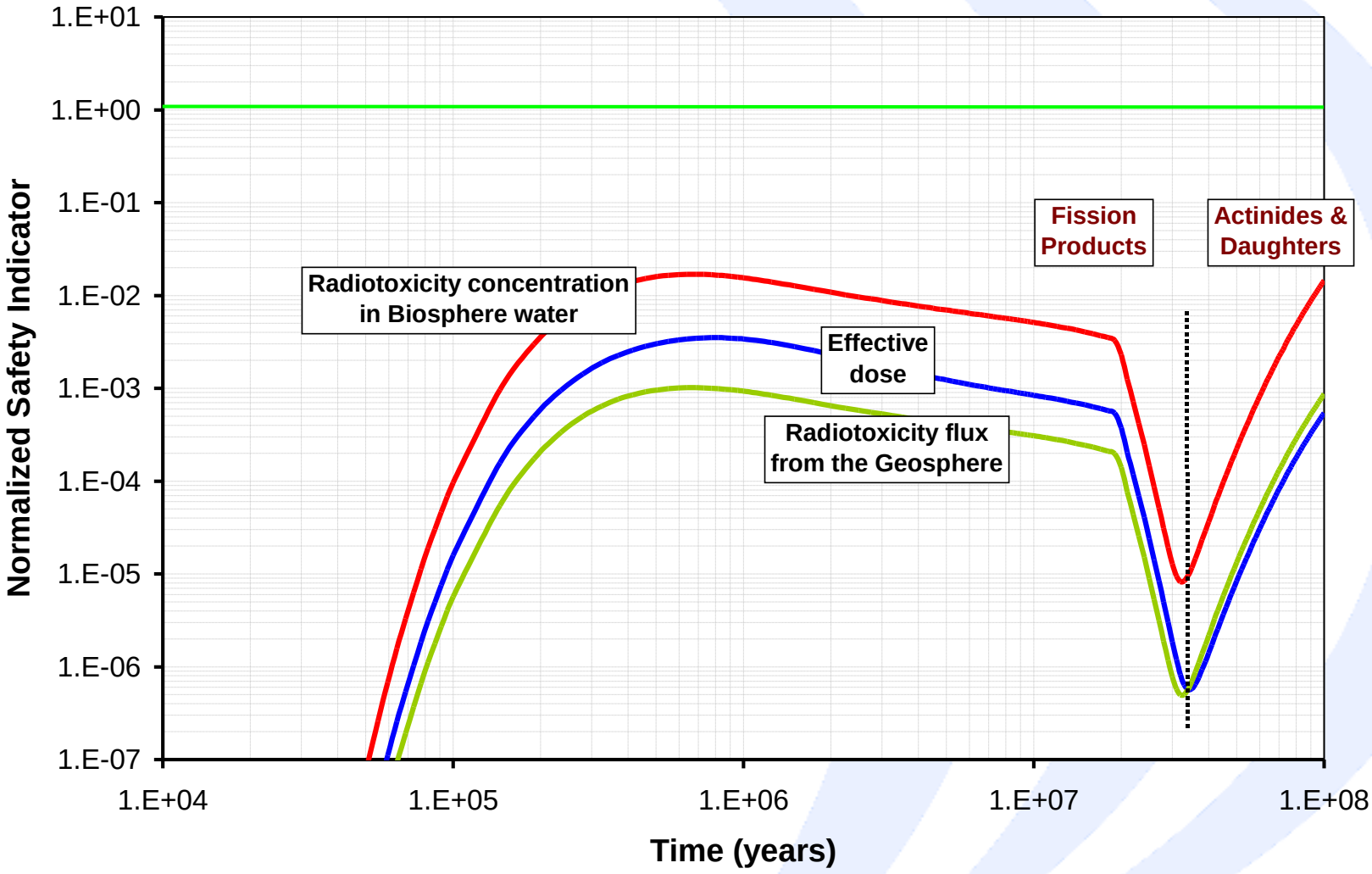
RTDC-3: Other Methodological Advancements

- WP1: Scenario Development
  - Development of scenarios by applying safety functions and stylised scenarios
- WP2: Gas Migration
  - Determination and quantification of the impact of gas on the engineered and natural barriers
- WP3: PA approach to radionuclide source term modelling
  - More detailed modelling of the chemical environment
  - Upscaling from one canister/disposal cell to a large scale repository
- WP4: Safety indicators and performance indicators
  - Testing of safety indicators with host rock formations other than granite
  - Common understanding of the role of reference values

Safety & Performance Indicators



Safety Indicators for a repository in clay



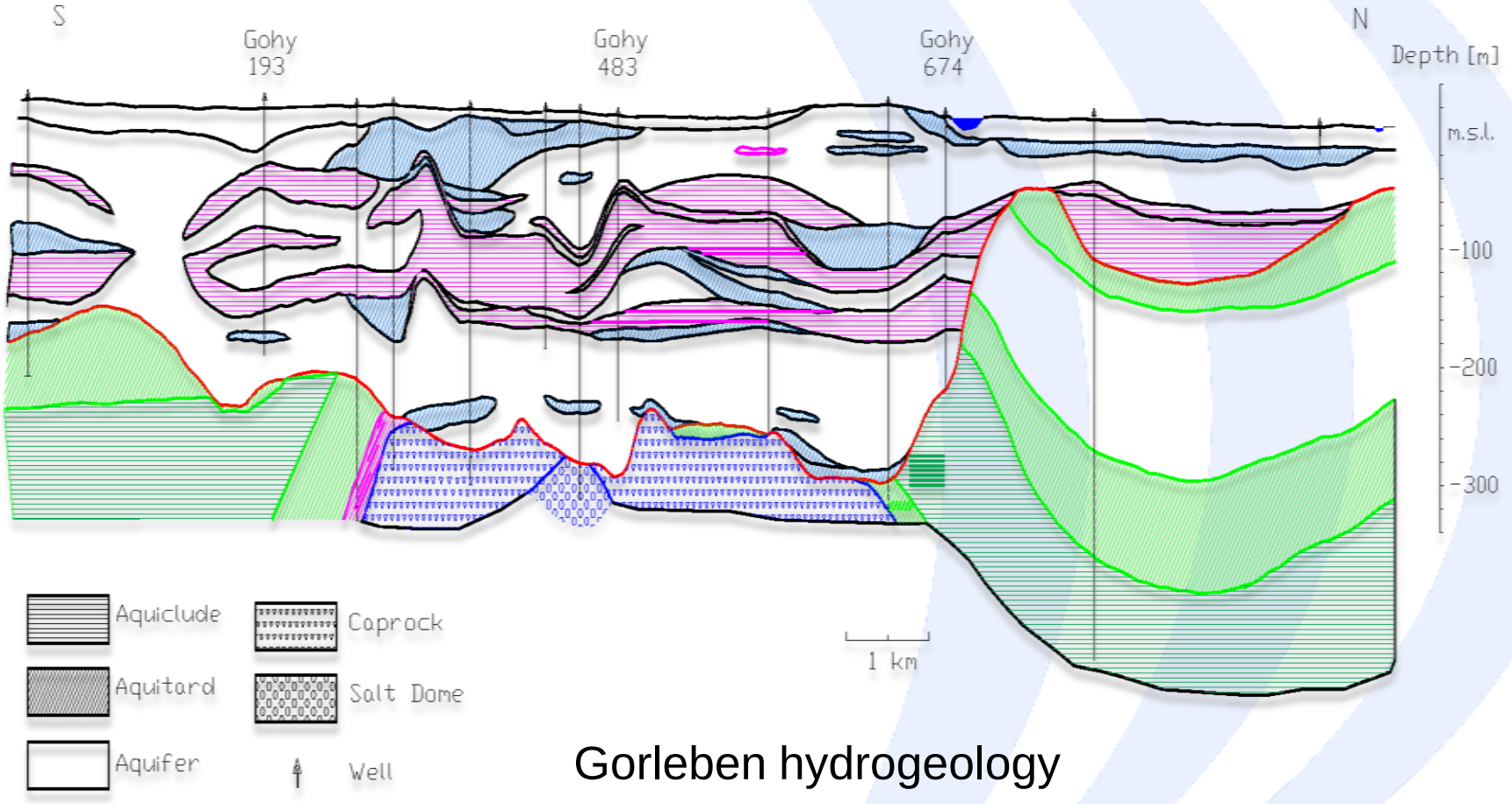
Safety & Performance Indicators - Results

- SPIN methodology has been tested for all kinds of host rock
  - Works well!
- Some new indicators have been identified and tested
  - Some more evaluation is needed
- Reference values for safety indicators can be local or global
- Performance indicators give a good insight to the functioning of system
  - Performance indicators of individual radionuclides are useful for identifying influential processes
  - Performance indicators are dependent on repository systems and host rocks

RTDC-4: Relevance of Sophisticated Approaches in Practical Cases

- WP1: PA approaches based on different complexity of process modelling
  - Salt as host rock
    - Convergence of salt
    - Brine intrusion into a backfilled drift
    - Radionuclide transport by density driven exchange
  - Radionuclide migration in the near-field (granite and clay rock)
    - « Kd » and « solubility limit » versus Geochemical transport
- WP2: PA approaches based on different geometric complexity of modelling
  - 1D versus 2D/3D codes (different problems and different host rocks)
- WP3: Uncertainty analysis codes
  - Uncertainties of parameters of host rock, bentonite buffer, bentonite plug and seals on nuclide migration

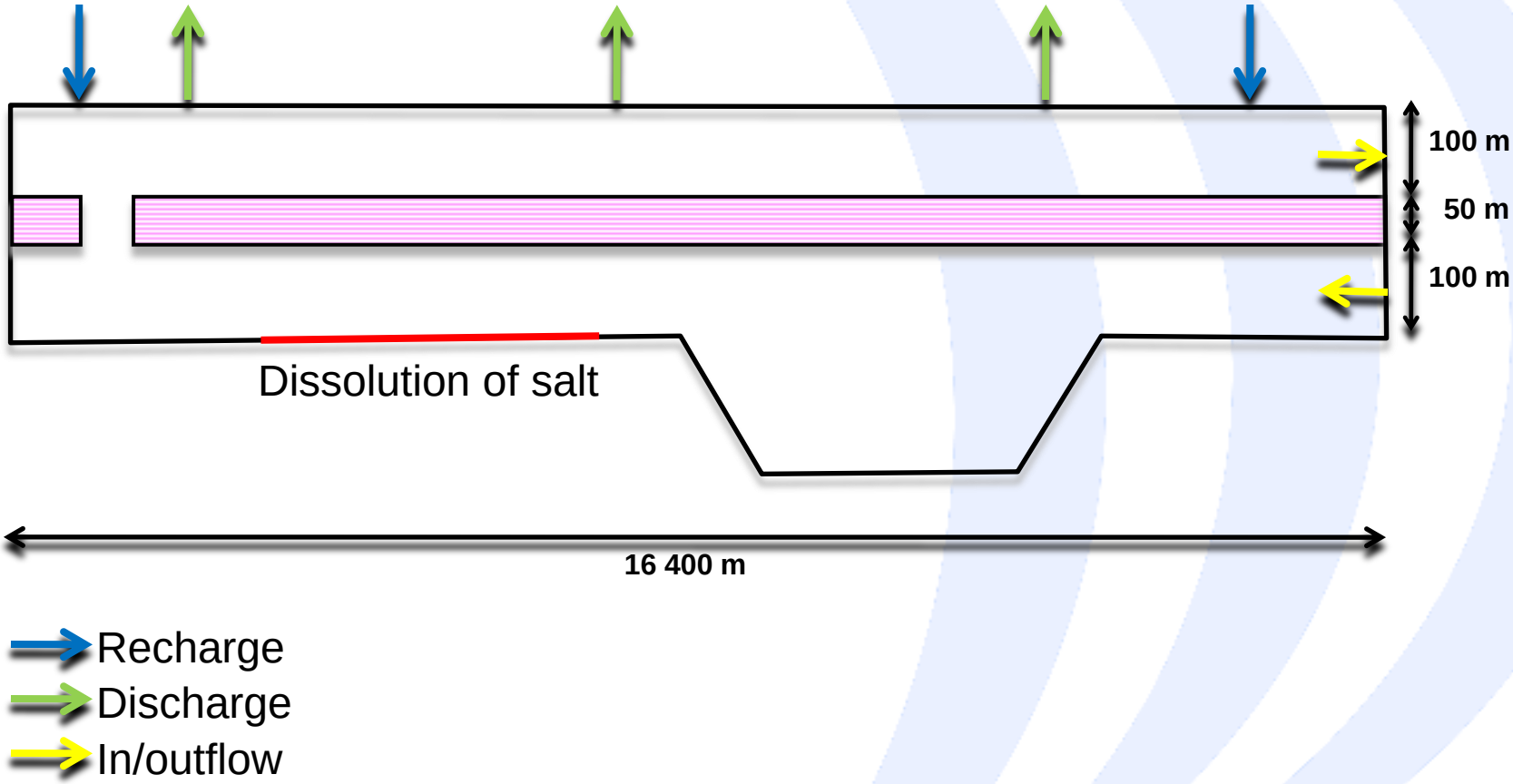
Geometric Model Complexity



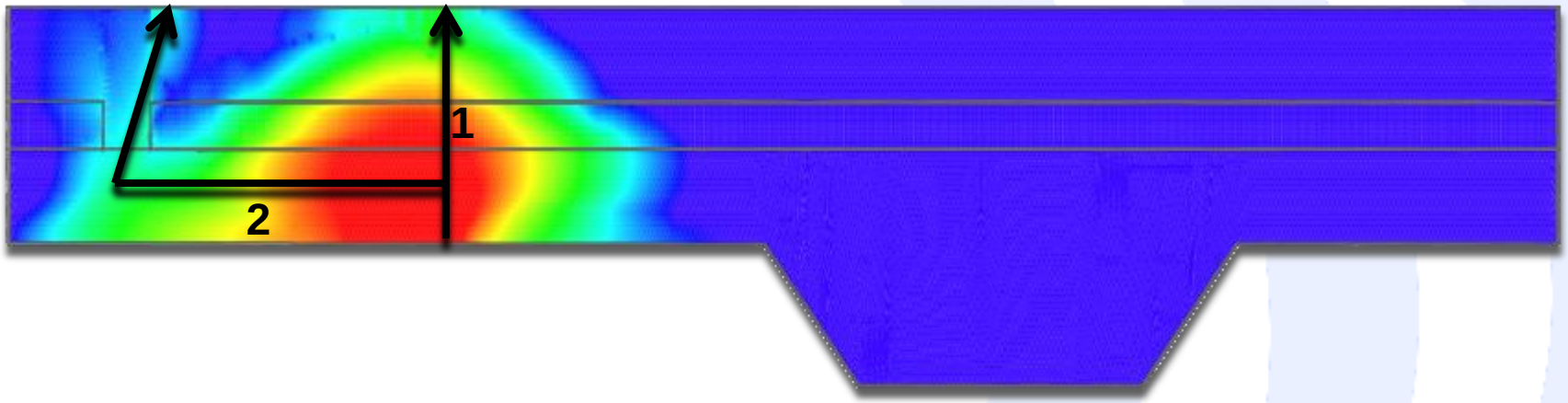
Gorleben hydrogeology

Klinge et al. 2007

Geometric Model Complexity – 2D model

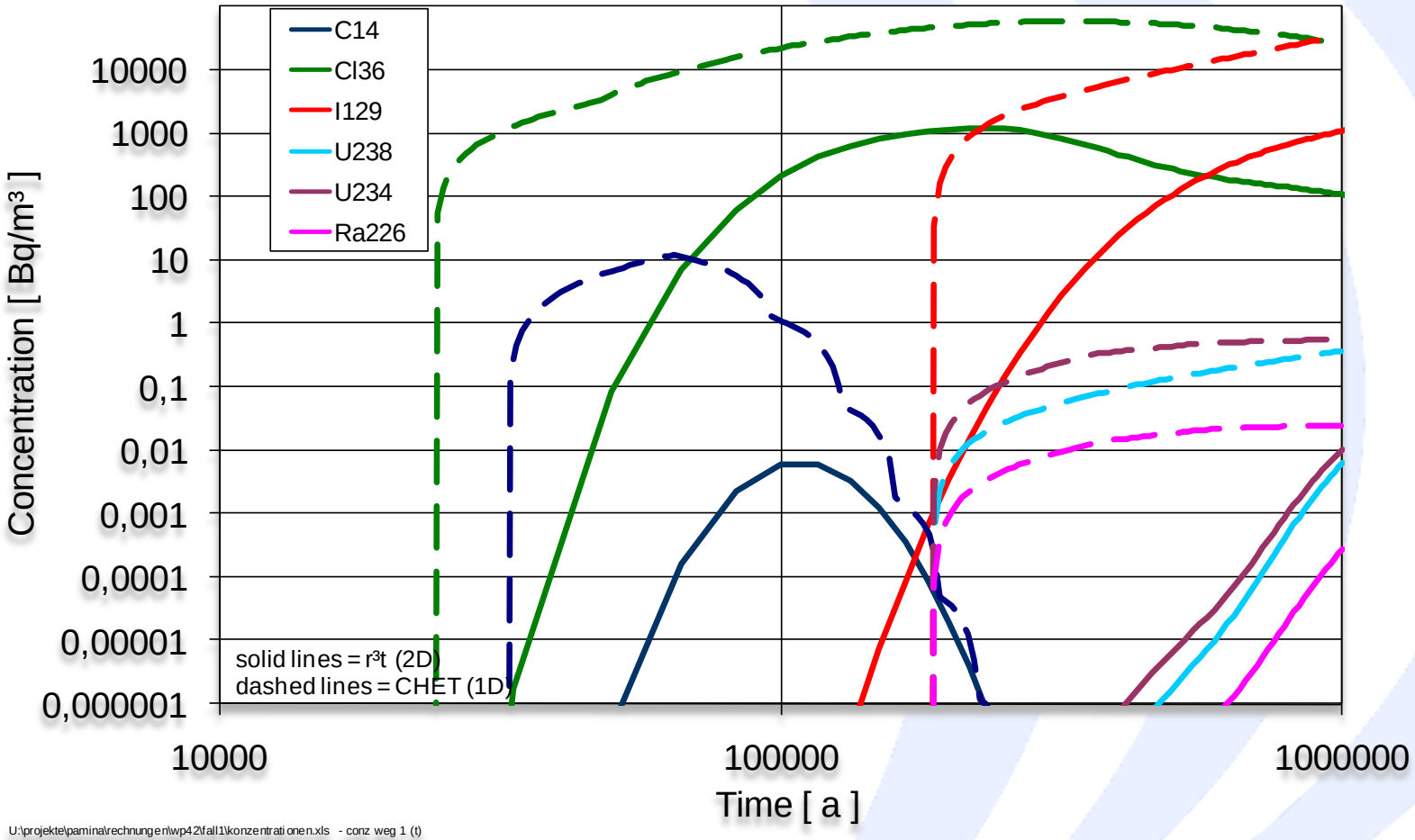


Geometric Model Complexity



two main RN pathways

1D vs. 2D transport - pathway 1



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Geometric Model Complexity - Results

- Despite the same flow-field, different radionuclides can be transported on different transport pathways depending on their transport properties
- 2D model is needed to predict point of maximum surface concentration and to setup PA code
- 1D code overestimates concentration (dose) by one to two orders of magnitude
- Diffusion is badly represented in lower dimensional models
- The heterogeneity of the transport velocities and their averaging resulted in too short transport times in the 1D model
- The fast transport at the end of pathway 2 resulted in insufficient time to bring decay chains into radioactive equilibrium

PAMINA - Results & Reporting

- Public access through PAMINA Internet page (www.ip-pamina.eu)
  - finally about 30 deliverables
  - five deliverables available already
  - in addition relevant milestone reports
- Final Annual Workshop
  - Sept. 28 – 30, 2009
  - Schloss Hohenkammer (near Munich), Germany
- Training Course
  - Sept. 24 - 26, 2009
  - GRS office, Neuherberg (near Munich), Germany

PAMINA Final Reporting