Support for site characterisation and geosynthesis

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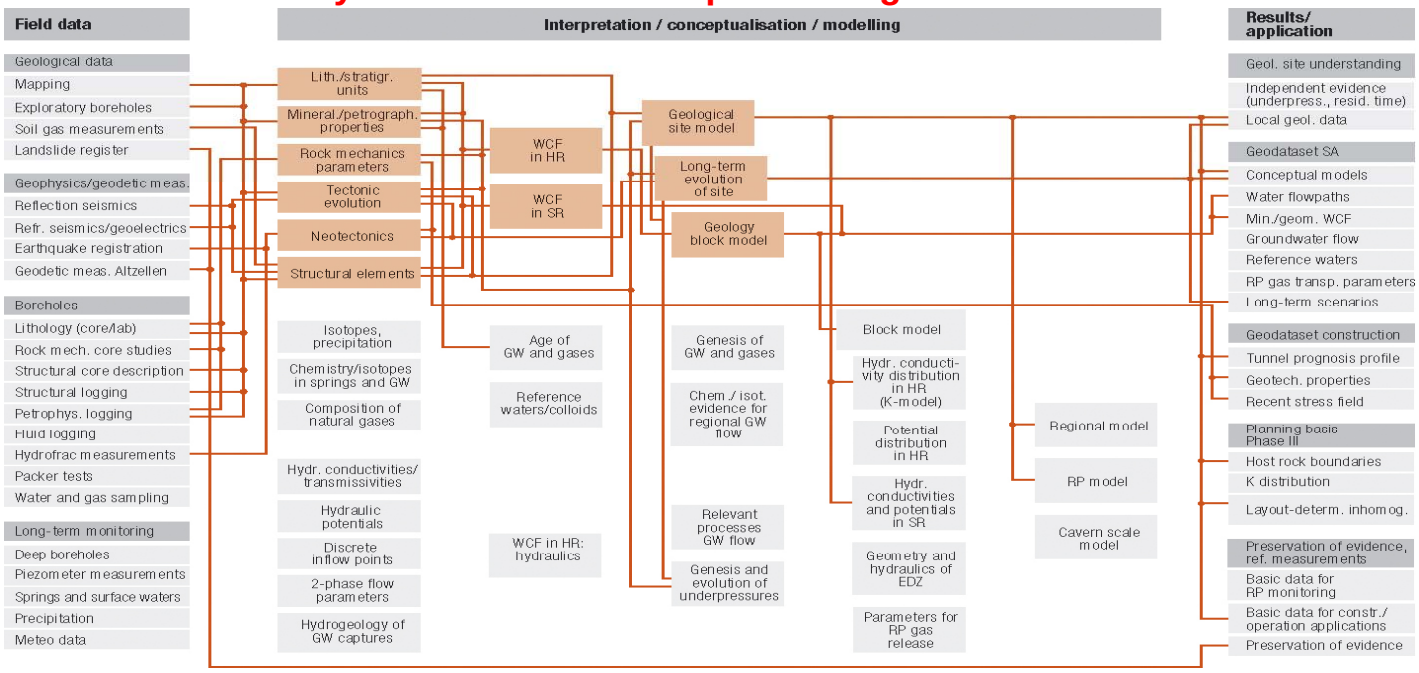
Site characterisation

- A dynamic and complex process that needs:
  - Close links to repository design and PA
  - Integration of a huge volume (and flux) of information into site descriptive models that evolve as investigation proceeds
  - Iterative review and modification of the characterization plan; based on improved understanding, changes in socio-political conditions or in the long-term disposal program and/or in response to technology development
- The challenge: development of advanced methodology
  - Information Synthesis and Interpretation System (ISIS)
    - A component of the comprehensive JAEA Knowledge Management System
    - Active application during site investigation, rather than simply recording what has been done by a conventional “static” methodology – e.g. “geosynthesis”
    - Use advanced technology from Knowledge Engineering; e.g. incorporating past experience and know-how (e.g. from URLs) into Expert Systems

Geosynthesis – linking data to user needs

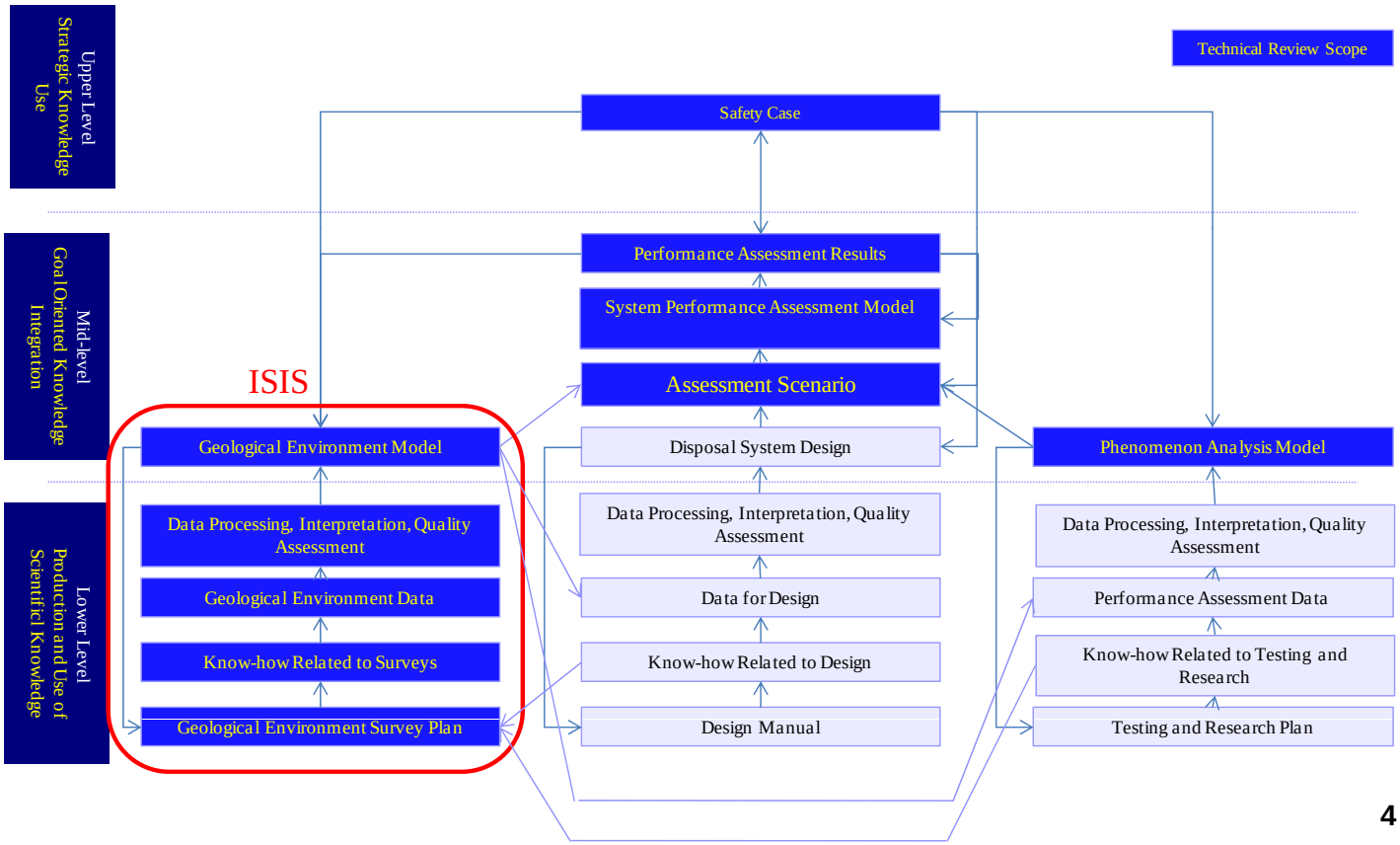
Information flow diagrams have been used to couple measurements in the field to the key safety functions of the natural barrier or parameters used for repository design BUT lack the flexibility to respond to surprises and have limited functionality for autonomic data processing



Objectives of ISIS development

- Supporting planning, implementation and integration of a site descriptive model (SDM) with associated site characterization data-set, based on past experience and know-how obtained in Japan (URL R&D) and elsewhere
- Aiding user-friendly communication with experts in different disciplines
- Providing flexible restructuring of information for performance assessment and design teams (and, potentially, communication with other stakeholders)

Role of ISIS in Safety Case development

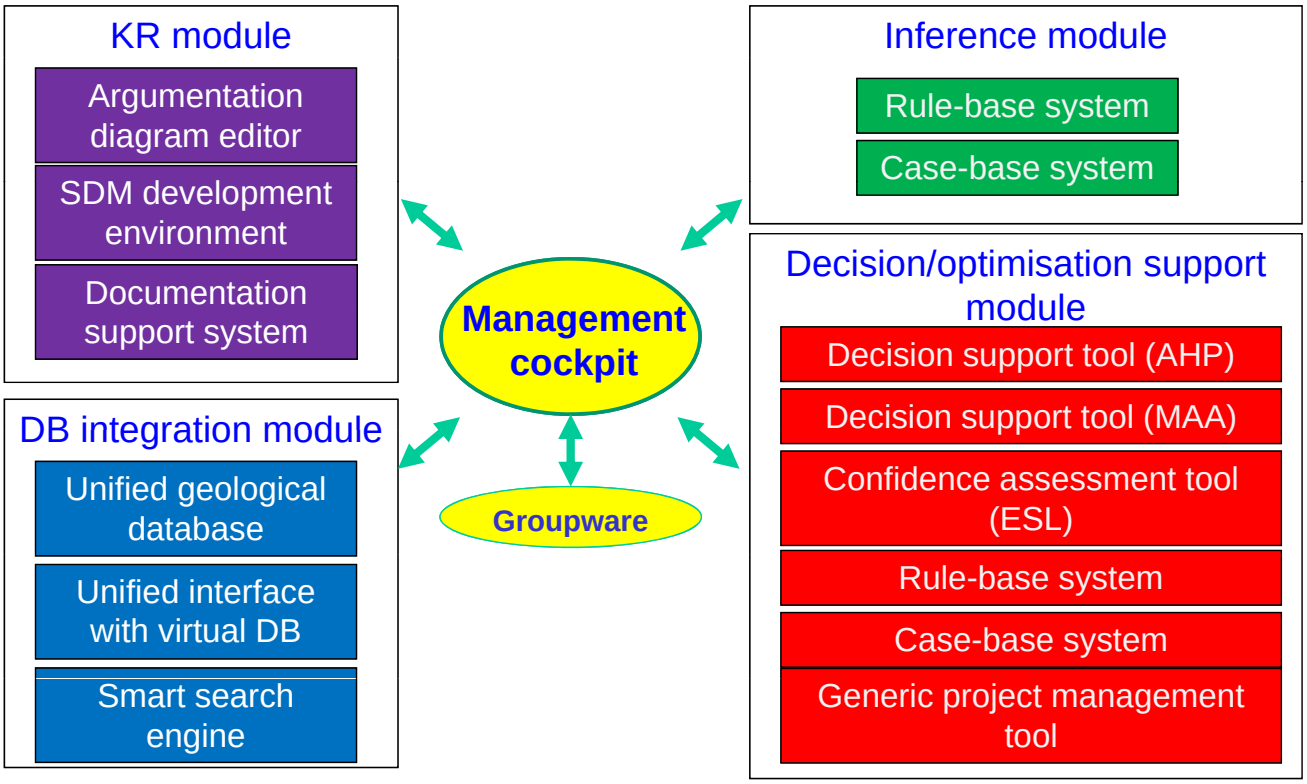


The ISIS toolkit

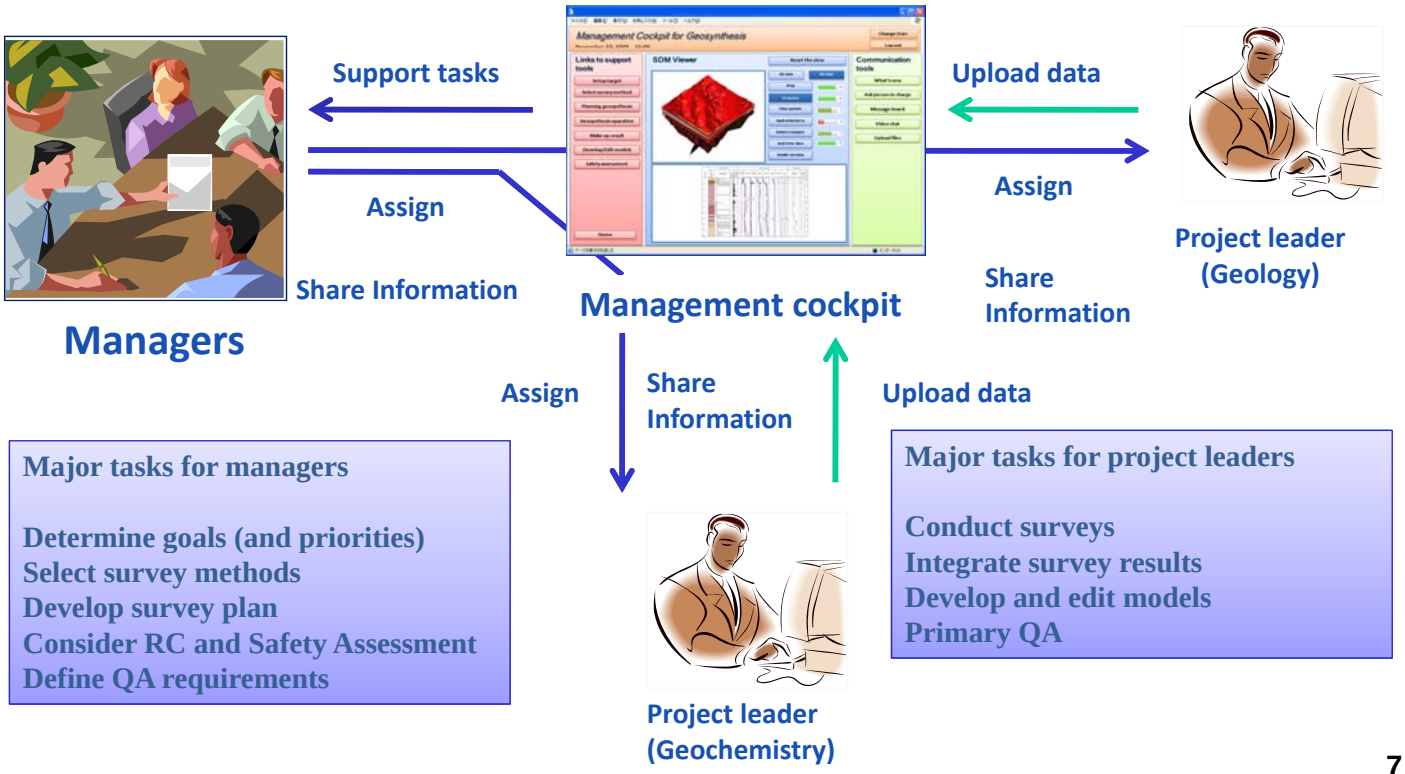
Key tools and methods currently investigated within ISIS

- Blackboard architecture: a method for efficient sharing and assessment of an evolving knowledge base
- Hybrid systems: pragmatic integration of IT methods with human experts
- Problem-solving methodology: formal approach for identifying conflicting requirements
- Expert system development tools: particularly focused on capturing tacit knowledge in rule-based or case-based systems

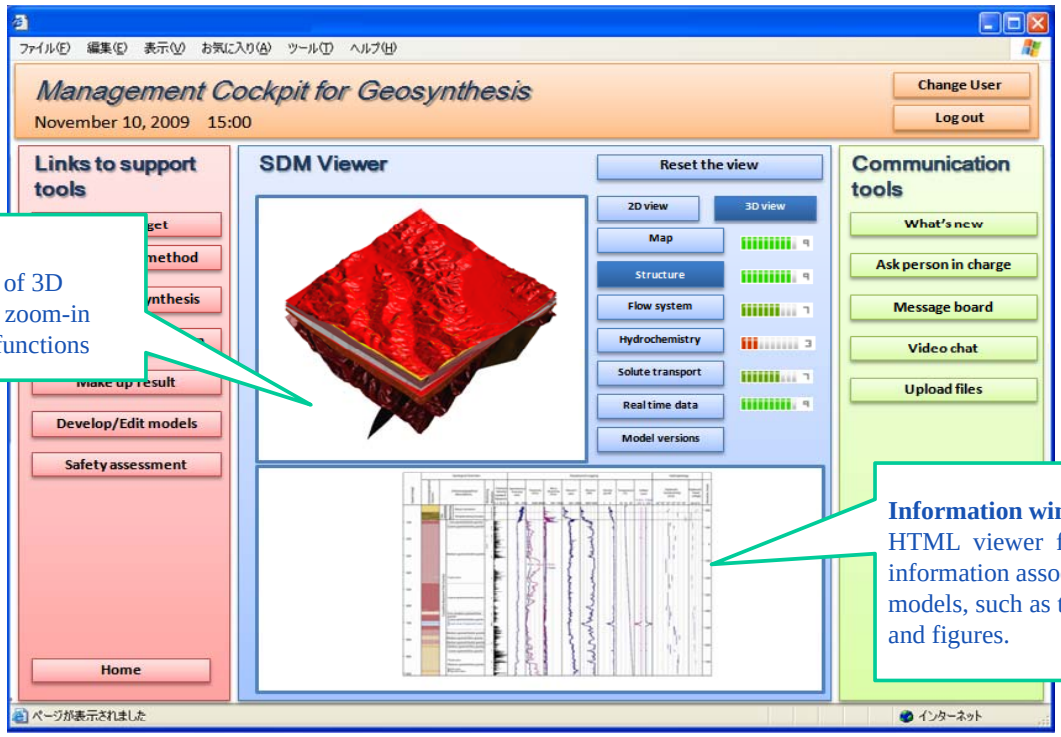
Overall structure of ISIS



Overview of the Management Cockpit for Geosynthesis: Relationships

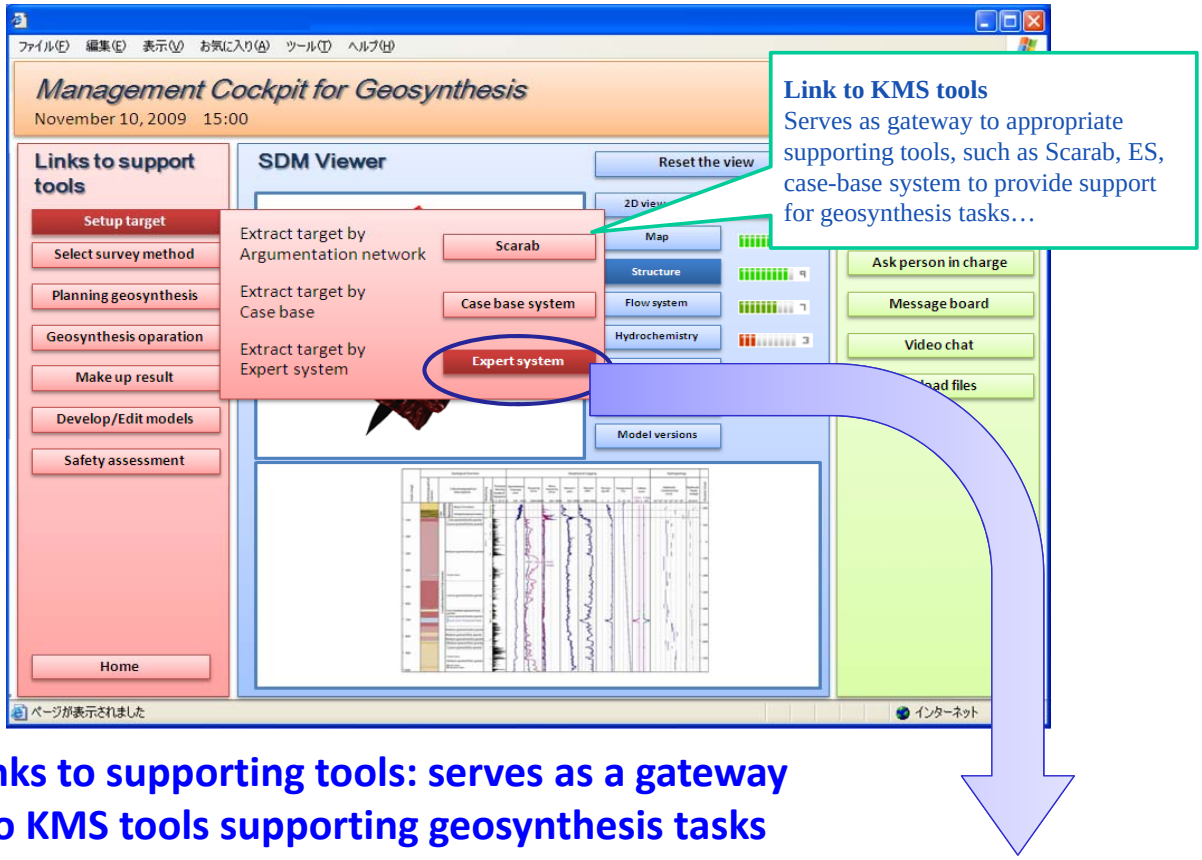


Management Cockpit for Geosynthesis: How does it work ? –SDM Viewer



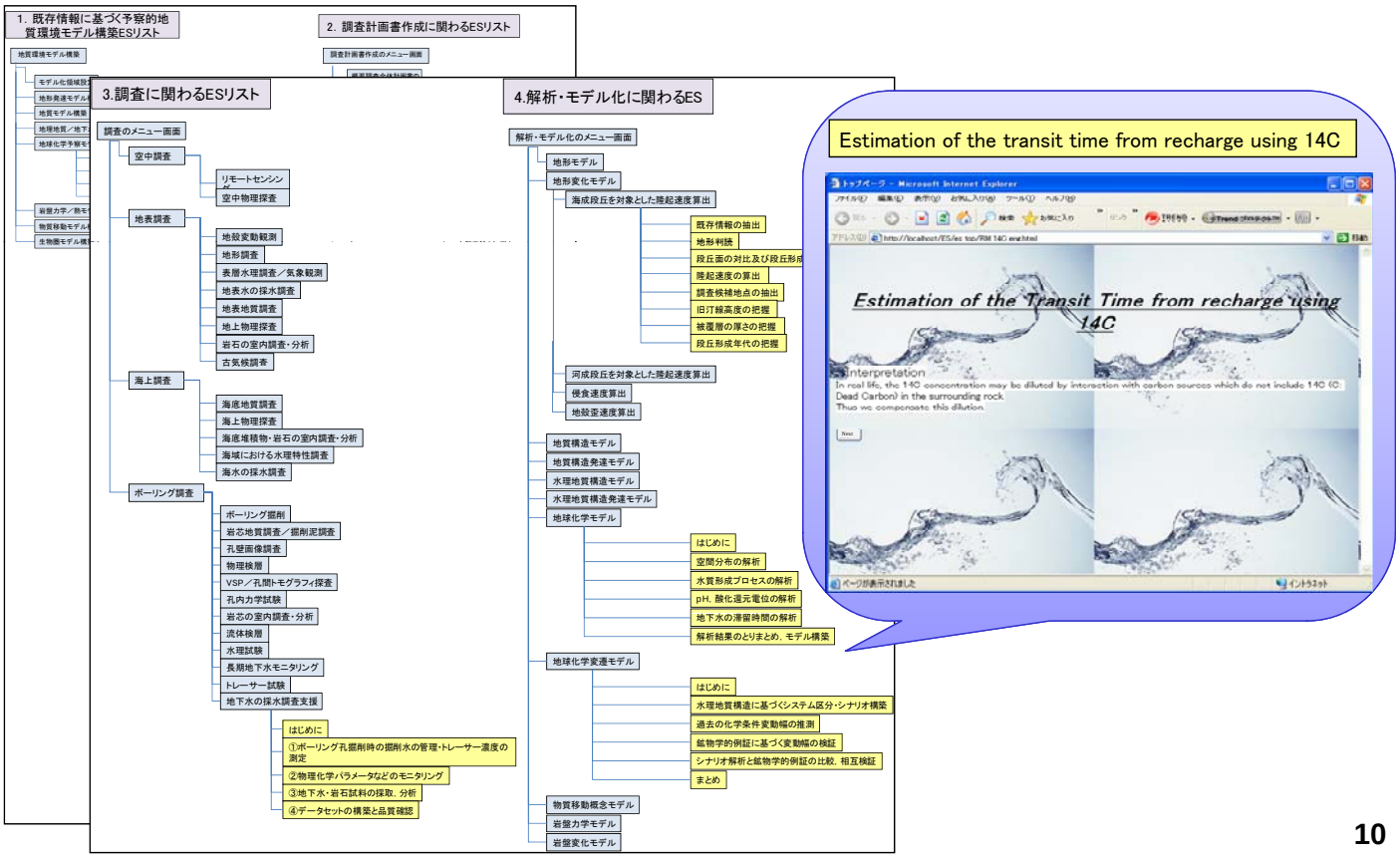
SDM viewer : serves as visual gateway to data and information

Management Cockpit for Geosynthesis: How does it work ? – Link to KMS tools



Links to supporting tools: serves as a gateway to KMS tools supporting geosynthesis tasks

Example of KMS tools
Lists of Expert Systems for site characterization



Procedure for knowledge acquisition leading to ISIS development

Knowledge Acquisition

I. Task flow organization

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II. Extraction of related knowledge items

Knowledge Modeling

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III. Construction of ontology model in Protégé

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VI. Syntax analysis of rules and cases

Expert Systemization

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V. Creation of an interface template and formulating knowledge elements as a menu, based on the results of syntax analysis.

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VI. An expert uses the interface in step “V” to create the rule base and case base by selecting knowledge elements and syntax.

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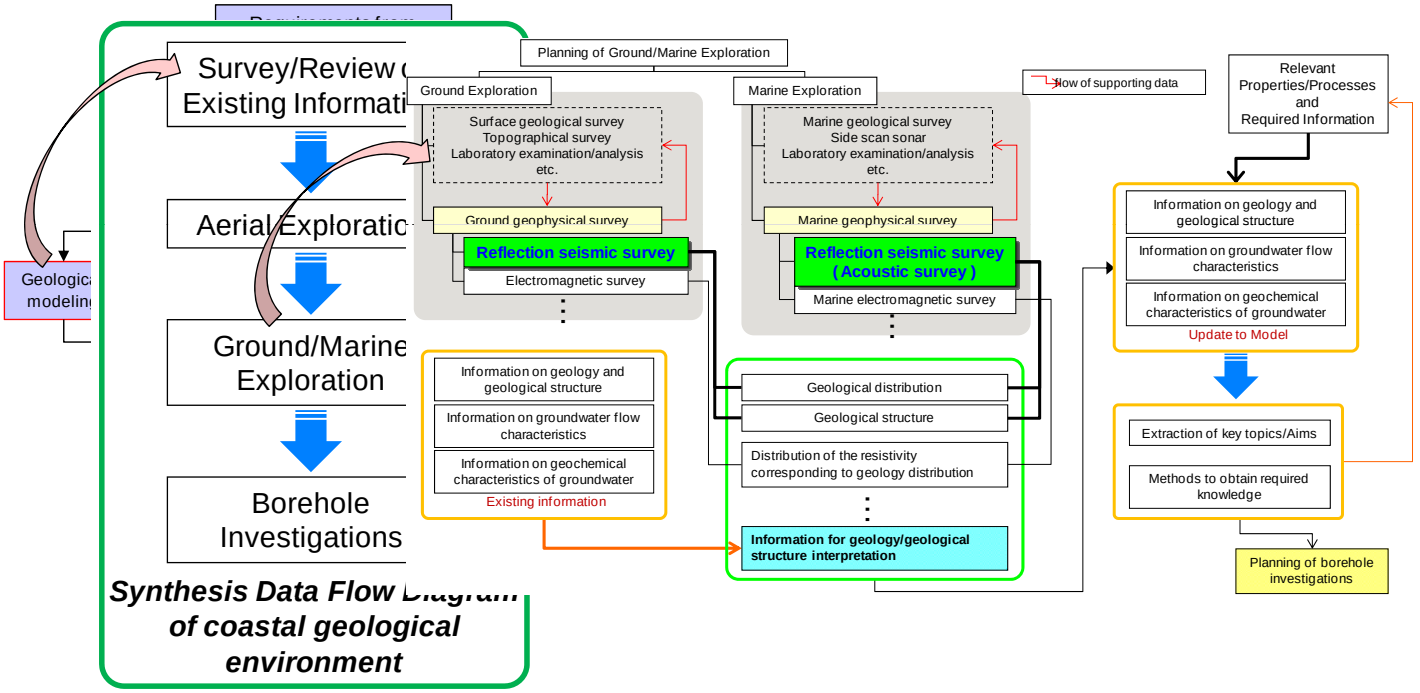
VII. The expert system group is produced automatically.

Detailed System Setup

Task flow analysis

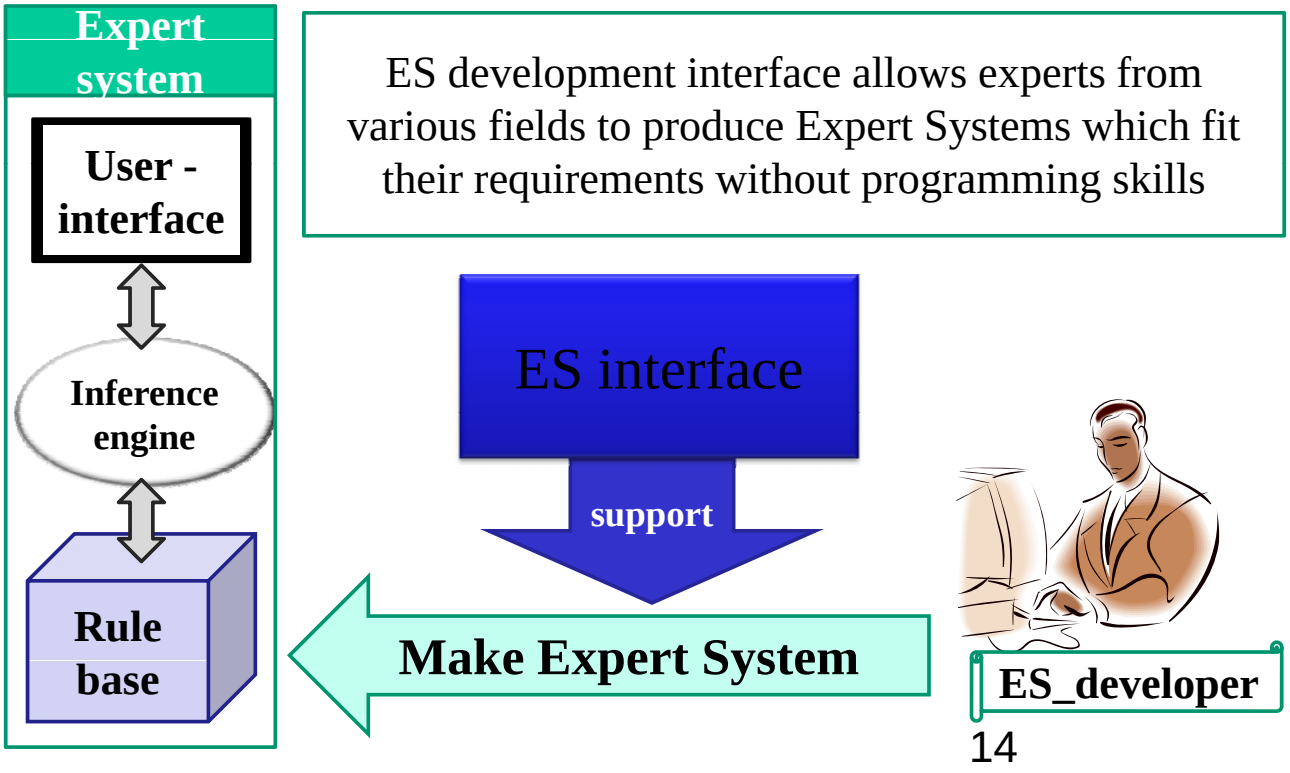


Identification of relevant knowledge elements

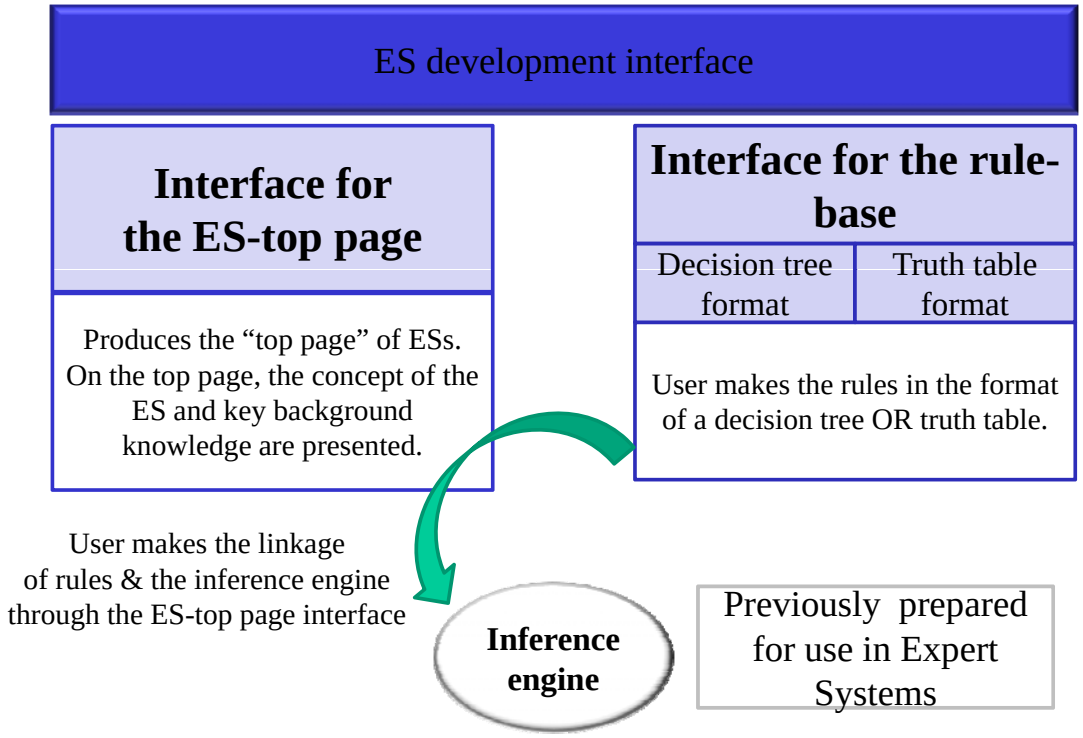
- Rule-base and Case-base -

Rule-base	Decision-making rules within tasks of site investigation, represented using IF...THEN format	e.g. Selection of drilling methods If full core recovery needed YES Then a wireline drilling method should be selected NO Then a non-core drilling method should be selected (tricon bit, etc.)
Case-base	Cases how a problem in site investigation was solved in the past, to suggest ways to handle similar problems in the future	e.g. Troubleshooting of drilling fluid loss

Concept of the ES development interface



The structure of the ES development interface

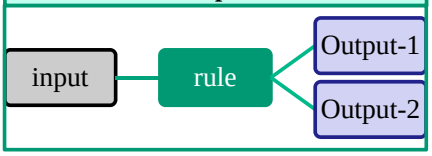


The Rule format

The Decision tree format & Truth table are appropriate for describing the characteristics of knowledge in relevant fields with the minimum of effort

The ES development interface allows both formats.

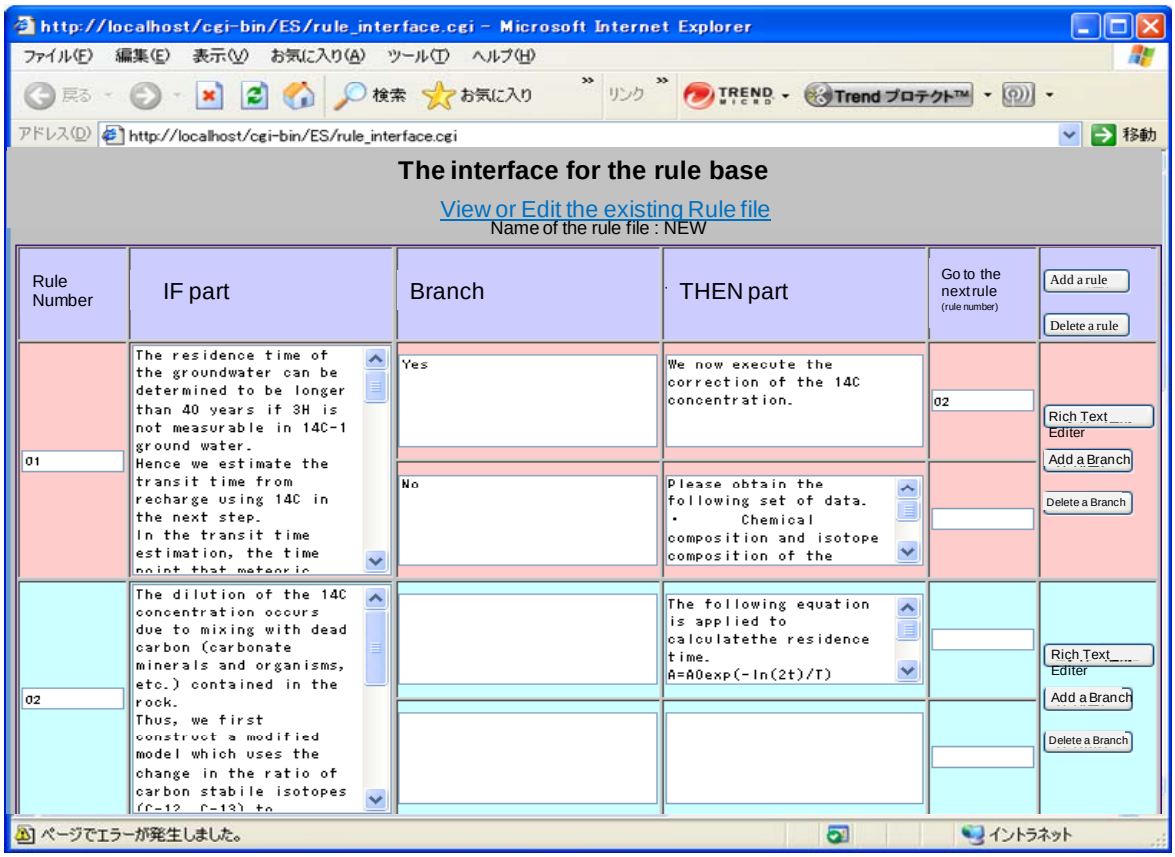
Decision Tree
When you make the rule in the form of input & if-then rule and output



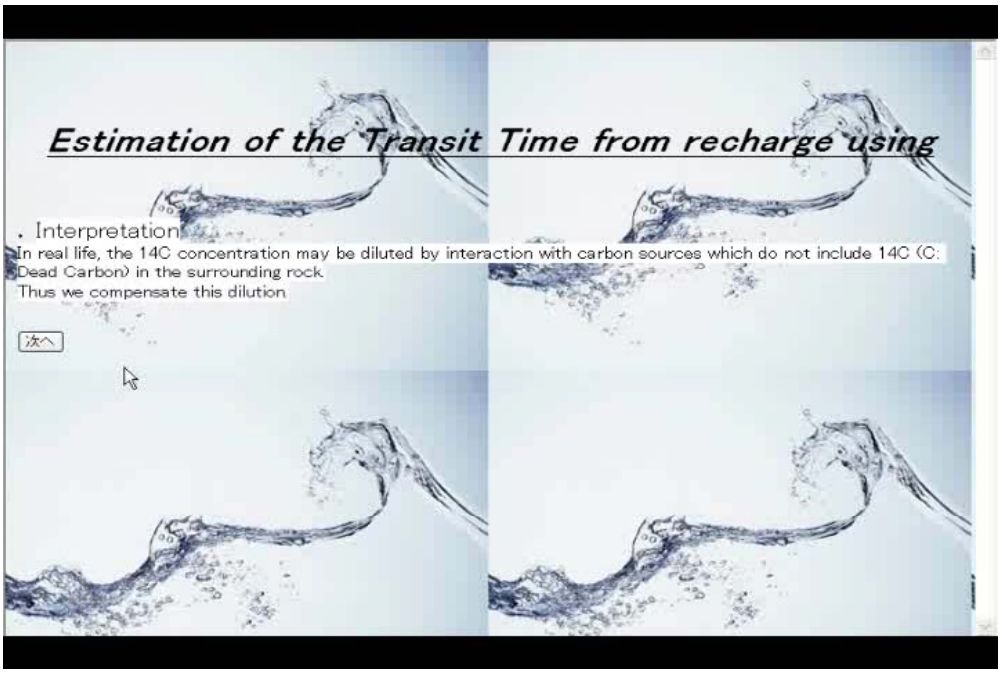
Truth table
When you want to describe all the requirement combinations and then choose the best option

	Requirement 1	Requirement 2
Method 1	○	○
Method 2	○	×
Method 3	×	○
Method 4	○	×

ES development interface
Rule-base editor



Example generated by using ES development interface



Conclusions and a look to the future

Conclusions

- The methodology and tools for acquiring required expert knowledge have been developed
- ISIS can provide a solution to the problems examined to date, especially when set within the context of an overarching KMS program

Future Plans (five-year program)

- Expansion of the range of test applications, leading to implementation of a system applicable to a volunteer site
- Extension of methodology from “simpler” rule-based reasoning to utilize more complex case-based knowledge
- Review of expert system contents in a formal manner, to support integrated QA of the KMS supporting Safety Case development