



RESQML V2.2

How the Geomodeling Community can take benefit of this standard?

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On behalf of



: www.energistics.org



Who is Energistics and who participates



Who is Energistics

- Energistics is a global, non-profit, membership consortium that facilitates the development and adoption of technical open data exchange standards in the upstream oil and gas industry.
- **Membership** consists of IOCs, NOCs, oilfield service companies, software vendors, system integrators, regulatory agencies, universities and the global standards community.
- **Standards** are developed by workgroups (known as Special Interest Groups, or SIGs) made up of industry experts from member companies.

In summary, the standards are created *by* the industry *for* the industry, facilitated by Energistics.



Energistics Members





What is RESQML ?



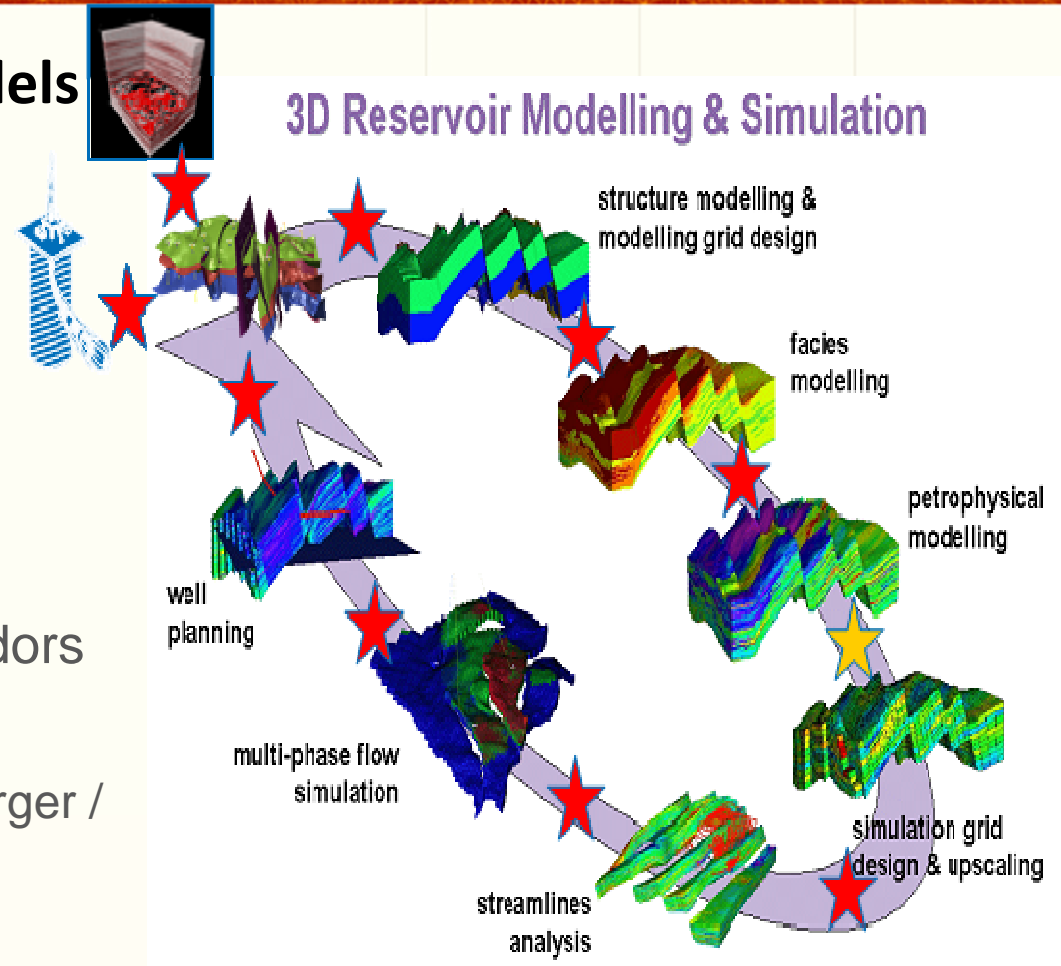
- **What Is RESQML ?**
- RESQML is an XML- and HDF5-based data-exchange standard that facilitates reliable, automated exchange of data among software packages used in subsurface workflows. RESQML consists of a set of XML schemas (XSD files) and other standards-based technology, which developers implement into software packages. Software that has implemented RESQML can read and write the standard format.
- RESQML has been developed by a global consortium of operators, service companies, software vendors, and government agencies under the umbrella of Energistics



RESQML 2.0 Solution Scope

A solution to exchange Geomodels

- On The entire workflow
 - Seismic to simulation
 - All kinds of grids
 - Traceability via metadata
 - Coordinate systems, etc.
- Supported by Geosciences Vendors
 - Already commercial
 - Paradigm / Roxar / Schlumberger / CMG / DGI / IFP En Group
 - Internally used
 - Total / Shell / BP / ExxonMobil
 - Open and free of charge !





PARTICULARITIES OF RESQML

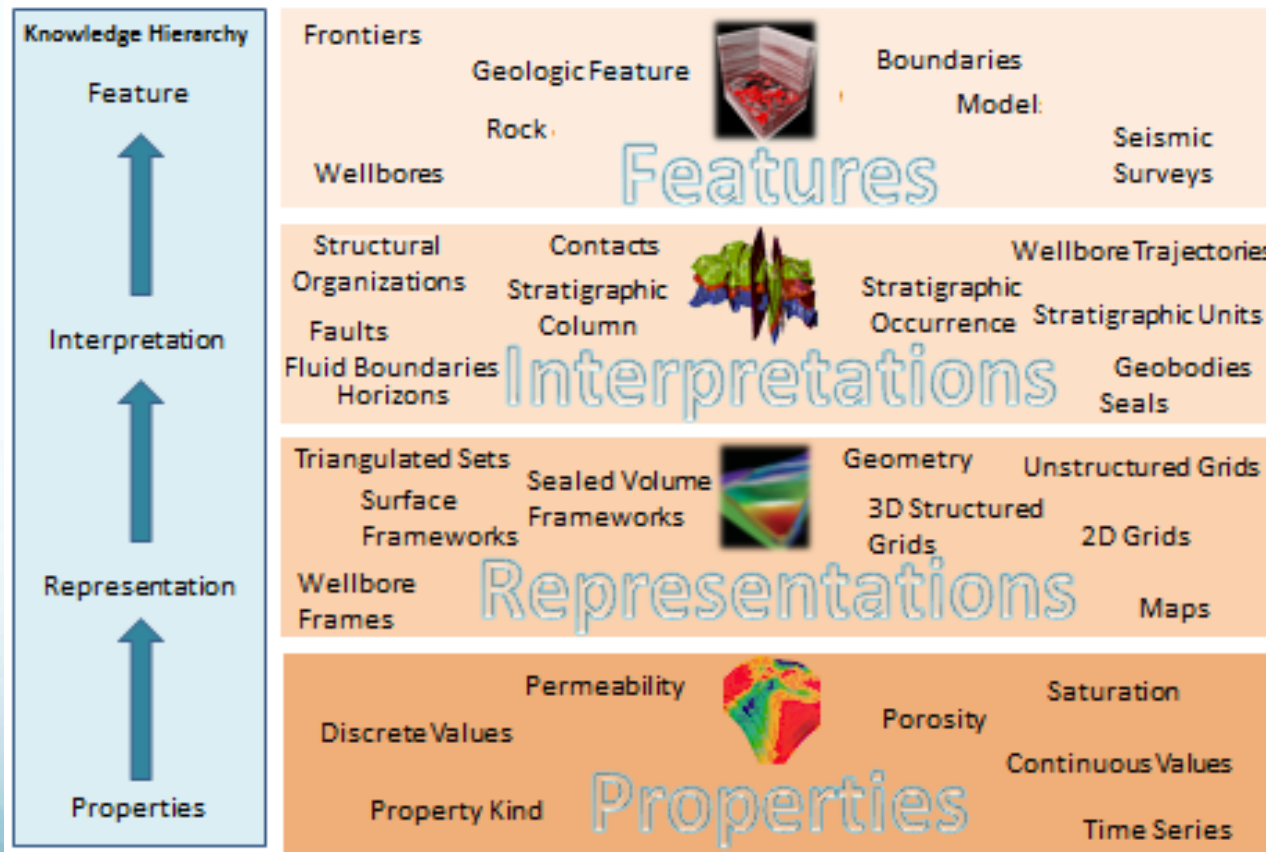
- Based on an UML 2 MODEL designed by Vendors and Petroleum Cies
- Inherits of more than 25 years of shared industrial Experiences
- Can be used on the entire geomodelling Workflow (in Petroleum Industry)
- Traceability is embedded (citation ISO 19115 and Activity Model).
- The Model is more complete than Models manipulated by Vendor products
- It is delivered, documented and maintained by an Open Consortium.
- Training, Open source APIs and software utility tools are available



PARTICULARITIES OF RESQML

THE FIRP : Feature / Interpretation/ Representation/ Properties

RESQML Knowledge Hierarchy and Data Relationships



- Reference (Individuals and Models)
- Interpretation Meta Information
- Topology & Geometry
- Properties (attached to topology)



PARTICULARITIES OF RESQML

FEATURE

INDIVIDUALS : ROCK / BOUNDARIES /
WELLS /
MODELS : STRUCTURAL /
STRATIGRAPHIC / RESERVOIR

REFERENCE to be managed
At the Corporate Level

1

1,N

INTERPRETATIONS

RESQML SPECIFIC
Designed to help Geomodelers iterations
(very next to GeoSciML semantic)

1

1,N

REPRESENTATION =
TOPOLOGY & GEOMETRY

CRS (COORDINATE
REFERENCESYSTEM)



1

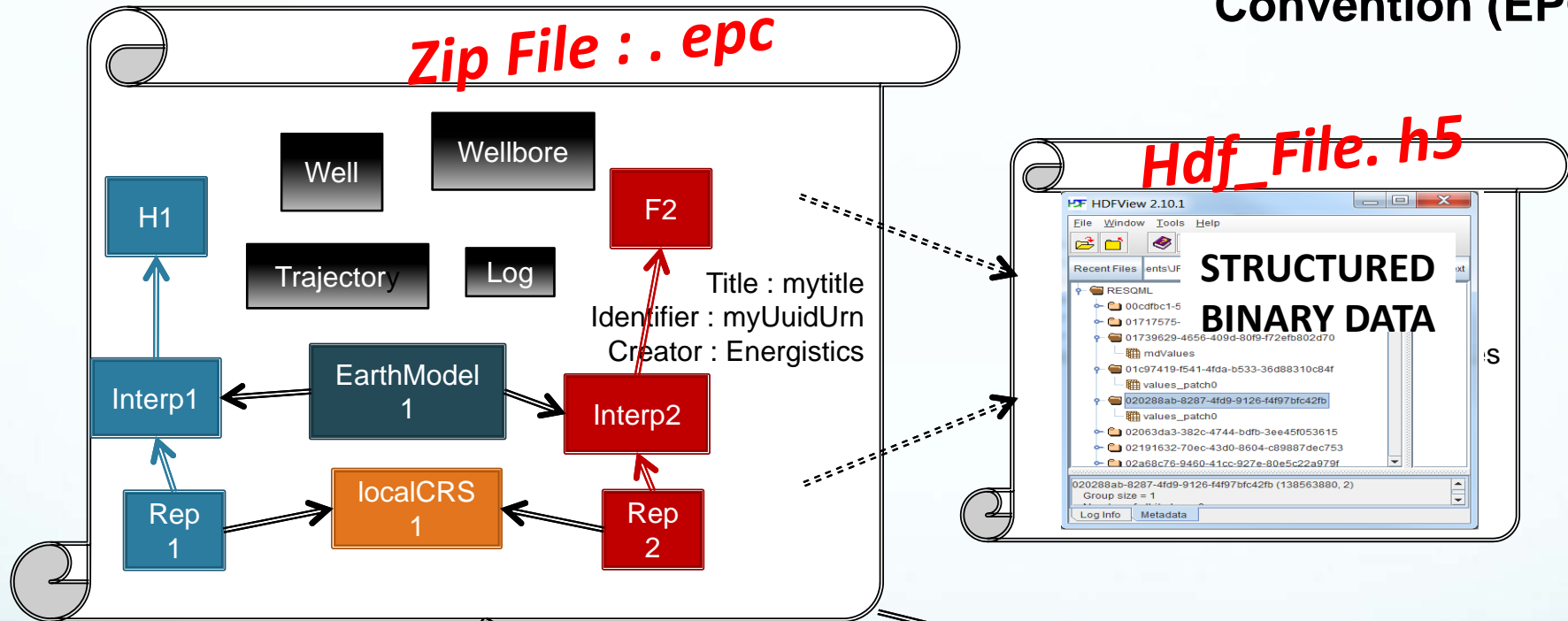
1,N

PROPERTIES

IN MOST OF CASES ,
These two Levels are the only ones
Managed by the Applications

UUID : Universal Unique ID on each top Level element

Plenty of xml files associated in the Energistics Packaging Convention (EPC)



Can be formatted using

Can be packaged into

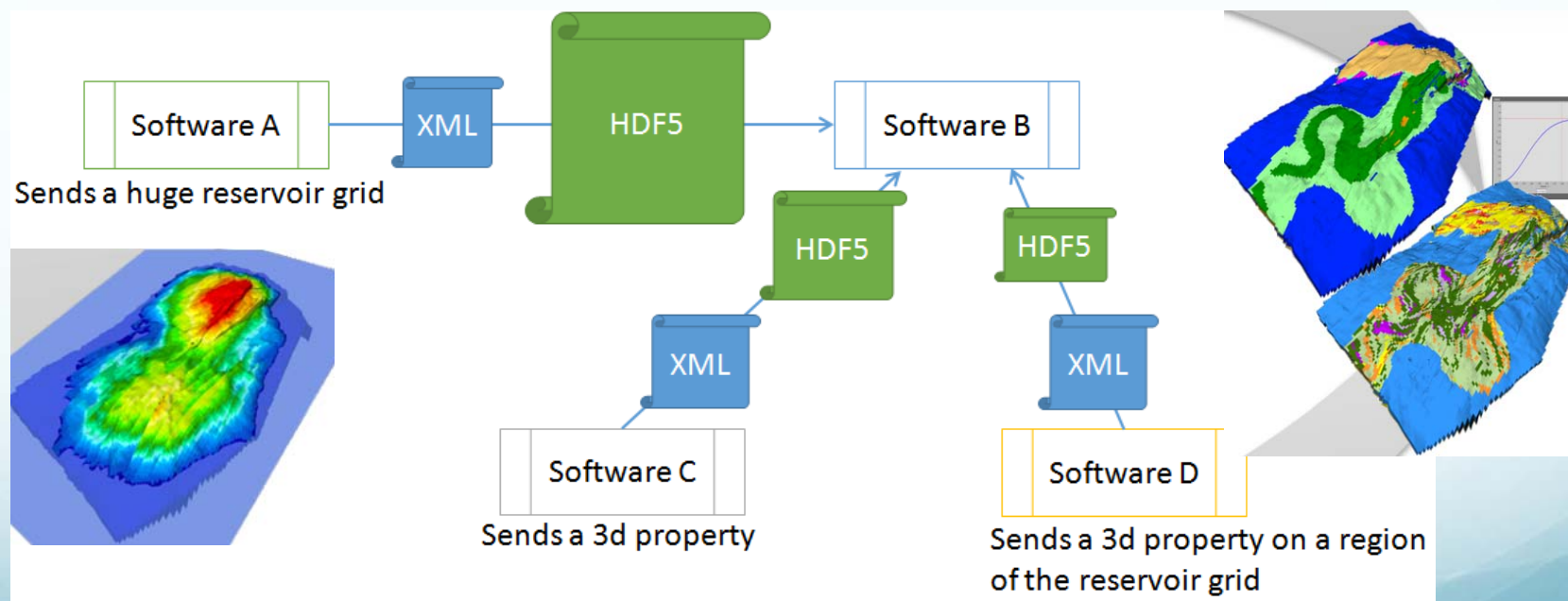




The partial exchange Use – Case

Partial Exchange

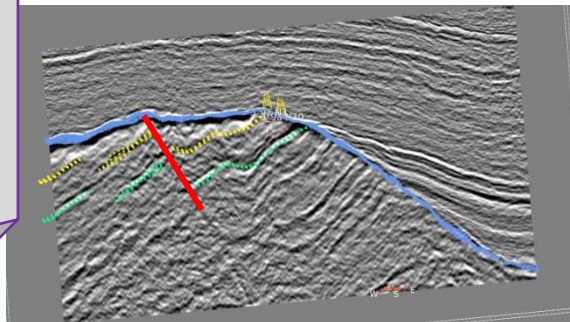
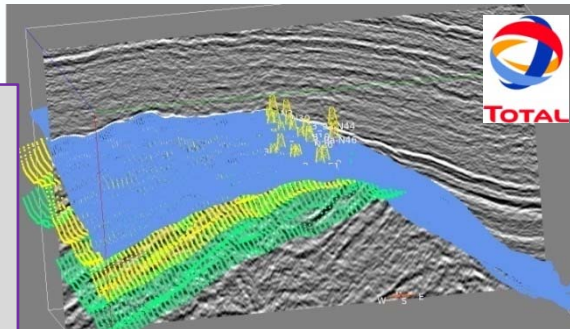
- To transfer a RESQML data object—in correct context—without all of its associated data objects and/or data.
- Do this when the model/data objects have been previously transferred and now you only want to transfer new or updated data.



EAGE '2011, Demonstrating the implementation of RESQML V1.1 Alwyn reservoir modelling & simulation workflow

ALWYN INTERPRETATION DATA SET

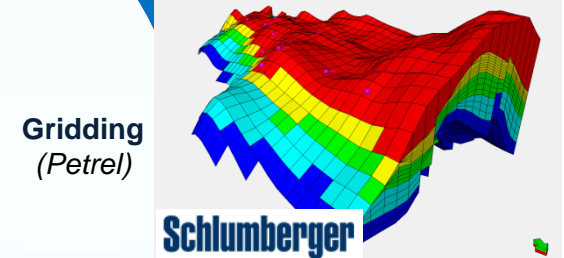
- ✓ 1 geodesy
- ✓ 3 horizons
- ✓ 4 faults
- ✓ Well markers
- ✓ metadata
(bibliography, creator name, creation date, contributor name, ...)



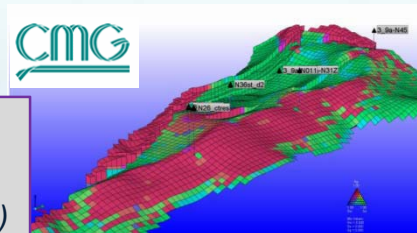
Seismic interpretation
(Sismage)



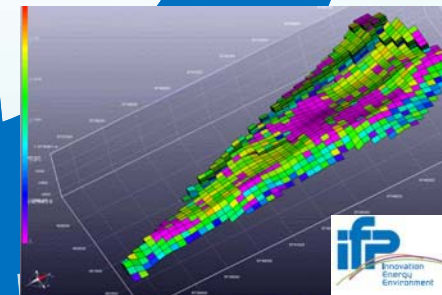
Structural modeling
(Skua)



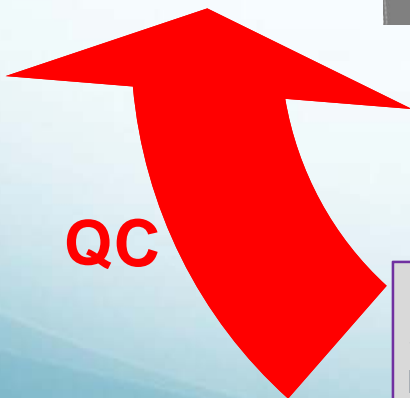
Gridding
(Petrel)



Dynamic reservoir fluid flow simulation
(Imex)



Static property modeling and upscaling
(Open-Flow)



OUTPUT DATA SET

- ✓ Simulated Reservoir Model (grid & properties)
- ✓ metadata (creator name, creation date, contributor name, ...)

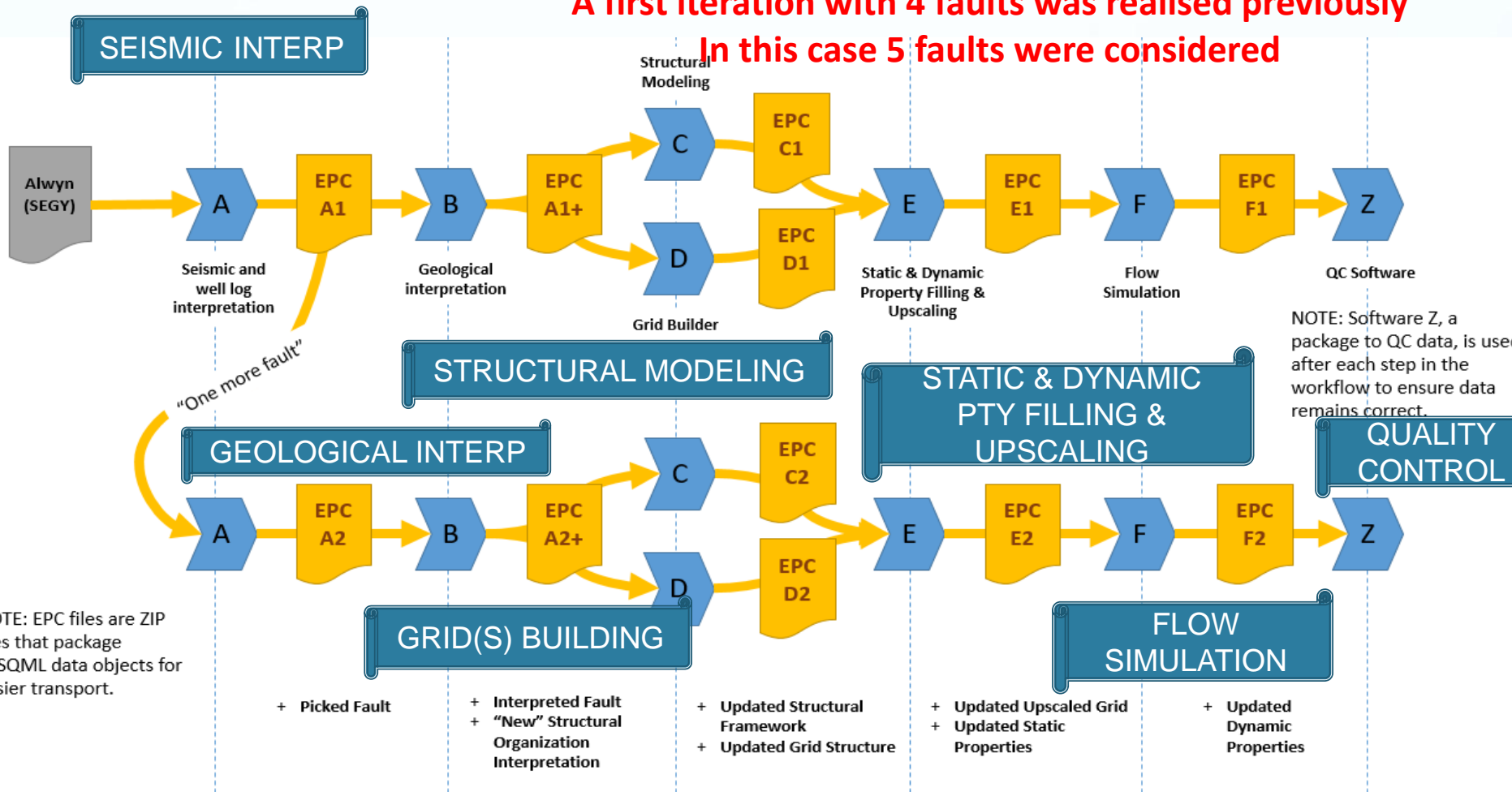


EAGE 2017 : 2nd Iteration of the Workflow presented (5 faults)

WELL LOG INTERP

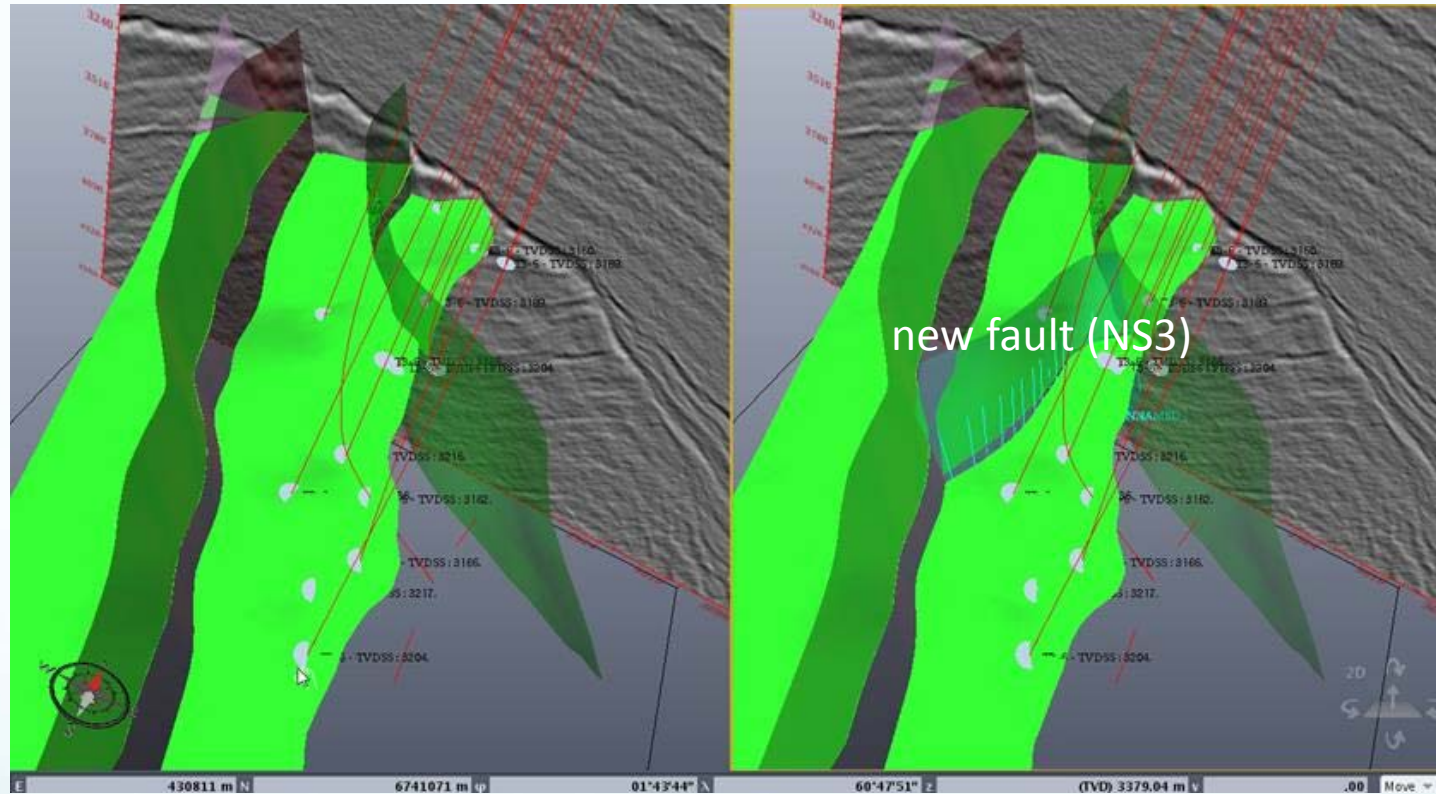
**Work flow followed for the second iteration:
A first iteration with 4 faults was realised previously
In this case 5 faults were considered**

SEISMIC INTERP



SOFTWARE A: Update the Fault Network

Step 2.1: Add (re-pick) NS3 fault.



Iteration 1 (left) and Iteration 2 (right)

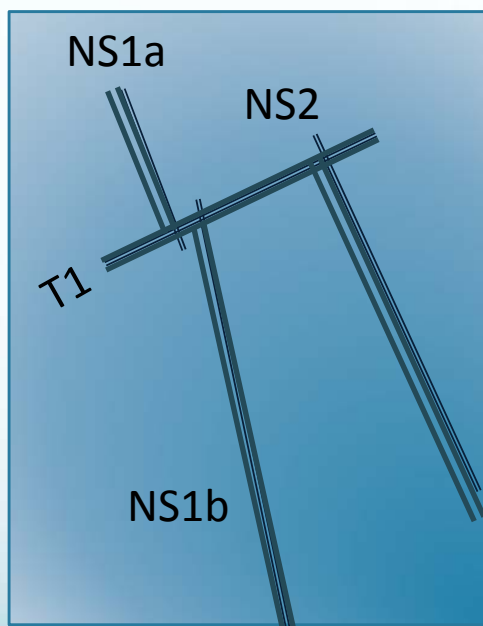


SOFTWARE B: Update the Structural Interpretation

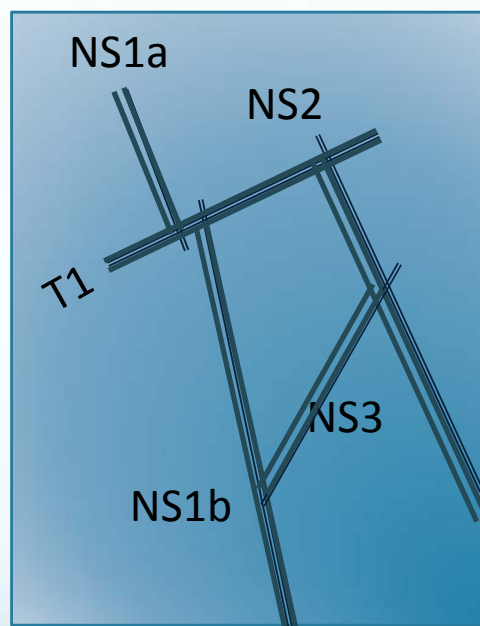
Step 2.2: Review geological interpretations.

Considered Faults: NS1a, NS1b, NS2, T1

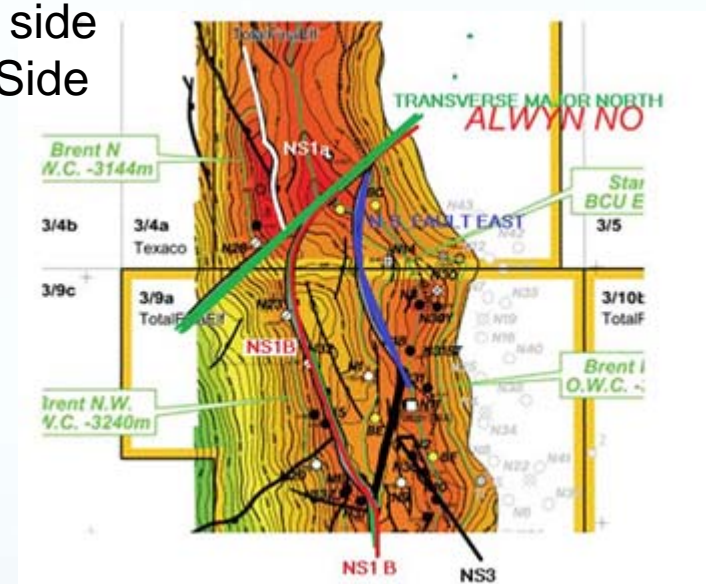
- Fault NS1a Stops at Fault T1 on its Footwall Side
- Fault NS1b Stops at Fault T1 on its Hanging Wall side
- Fault NS2 Stops at Fault T1 On its Hanging Wall Side



Iteration 1 (left)



Iteration 2 (right)



Considered Faults :

NS1a, NS1b, NS2, T1, NS3

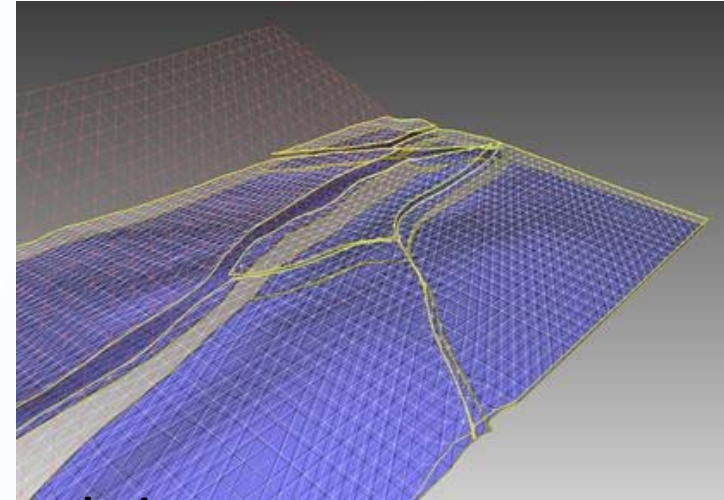
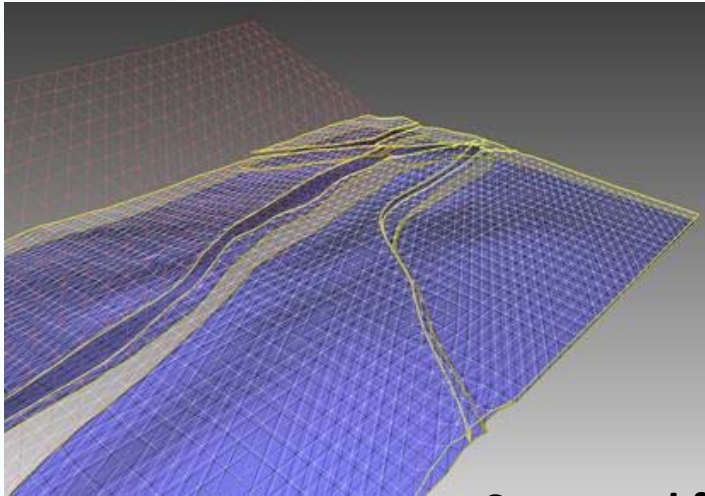
- Fault NS3 stops at Fault NS1b on its hanging wall side
- Fault NS3 stops at Fault NS2 on its foot wall side



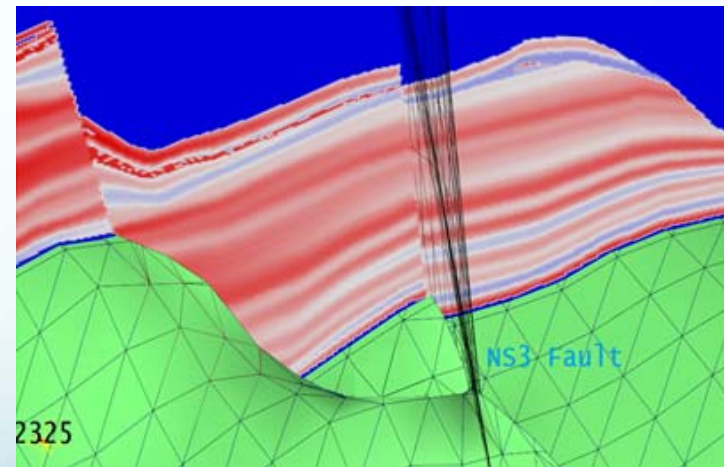
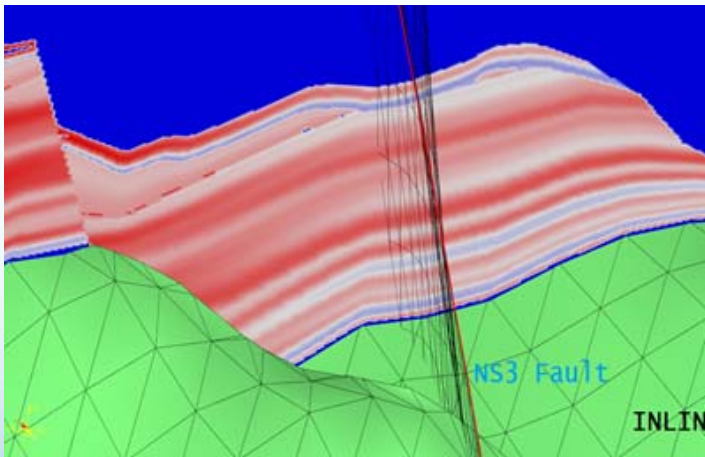
SOFTWARE C: Build the Structural Framework

Slide 18

Step 2.3: Update the structural framework and fill an *a priori* volume model for further seismic attribute inversion.



Structural framework view

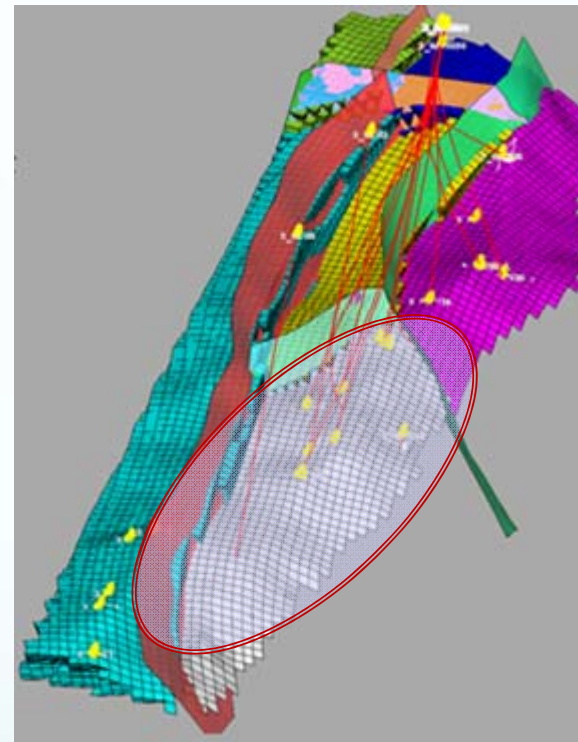
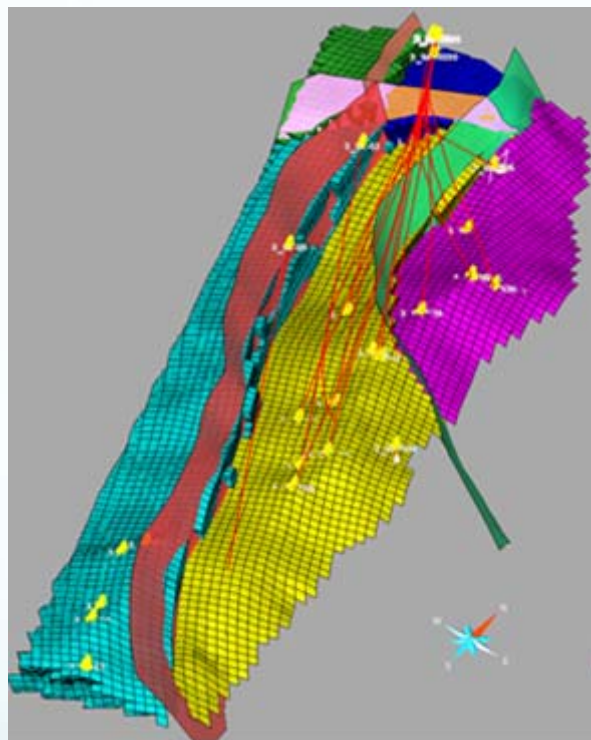


Inline view of the fine-scaled Cartesian regular grid with seismic acoustic impedance
Iteration 1 (left) and Iteration 2 (right)



SOFTWARE D: Build the Grid

Step 2.4: Build a 3D reservoir grid.



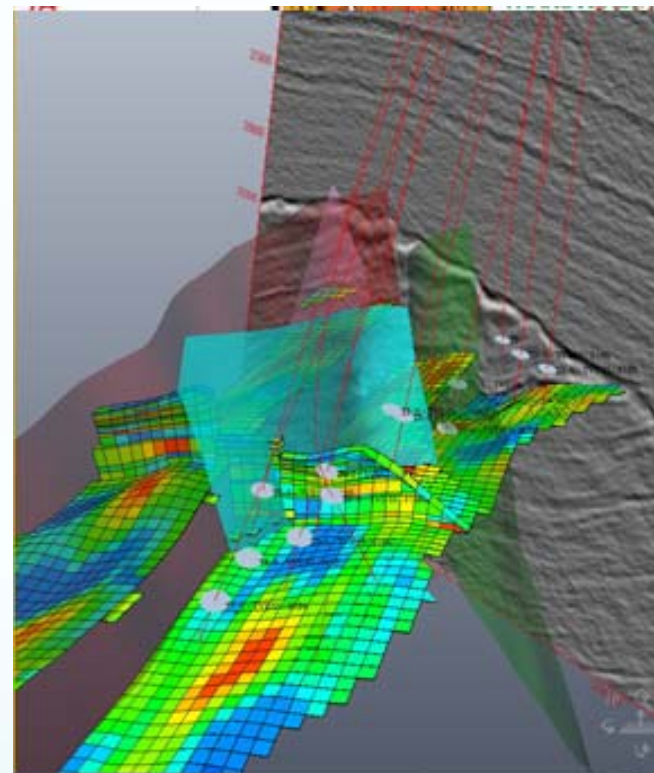
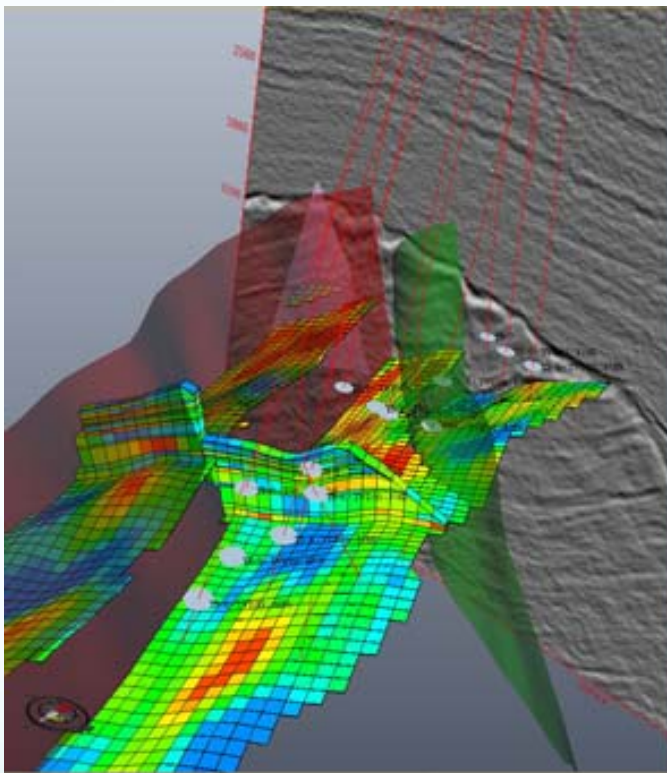
IJK reservoir coarse grid

Iteration 1 (left) and Iteration 2 (right)



SOFTWARE E: Upscale the Model

Step 2.5: Upscale the fine-scaled geologic model into the coarse-scaled simulation model.



IJK reservoir coarse grid with static properties (porosity) upscaled

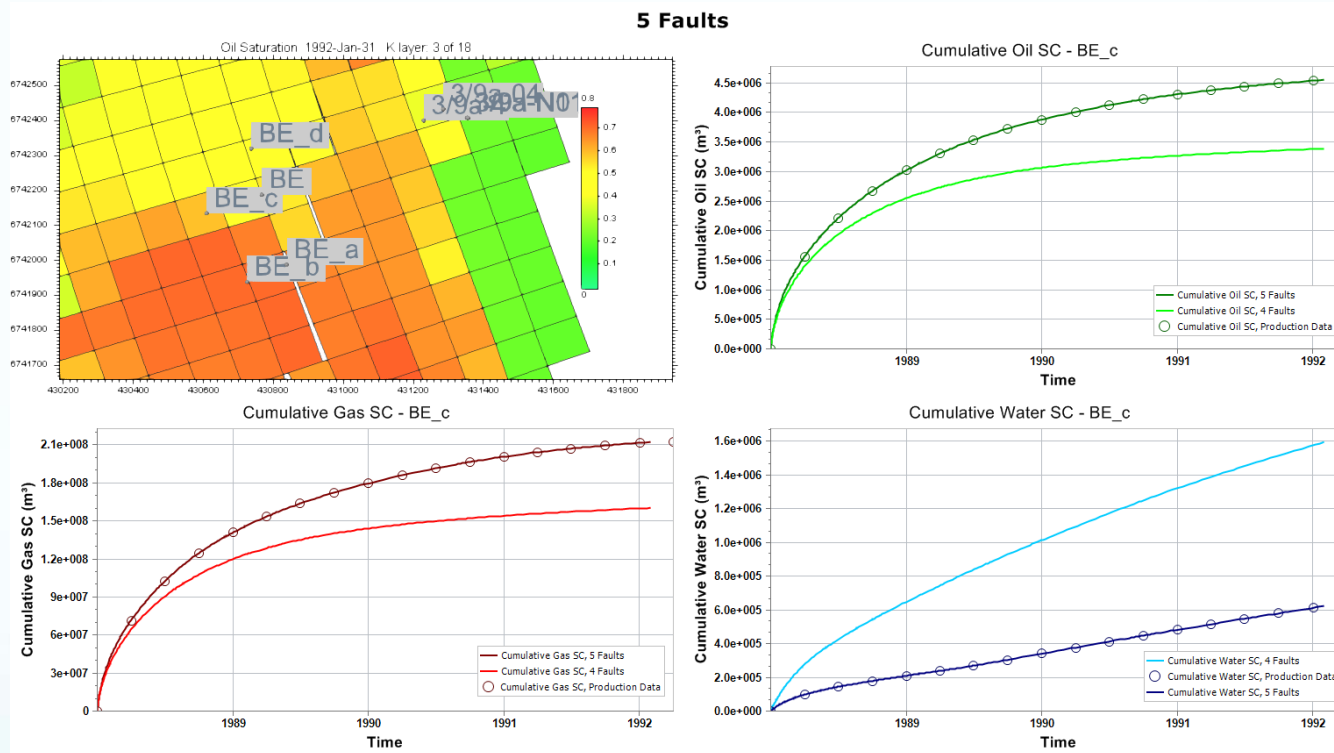
Iteration 1 (left)

and

Iteration 2 (right)

SOFTWARE F: Model Fluid Flow

Step 2.6: Fluid flow simulation.



Iteration 2 of the work flow results in a better history match (alignment of circles (production data) and solid lines (model)), without rebuilding the entire model from the beginning, updating/adding only the data required to add one more fault.



The Situation Today

- Last year, nearly all vendors in Petroleum Geosciences were adopting RESQML
- Their priorities were focused on Structural and Grid representations exchange.
- But the traceability advantages (UUIDs, Citation, Activity model) and the Interpretation management are not used as much as we could.
- Nevertheless, we can import/export nearly all the entities in the geomodeling process with this standard
- It 's looks mature and utilities to use it are Open source and free of charge.
 - You can find C++, C#, java read/write APIs, 3D user oriented « Paraview » visualisation, EPC exploration debugging and Validation Tools.



How the Geomodeling
Community can take benefit of
this standard ?



How the Geomodeling Community can take benefit of this standard ? . first by adopting and using it ..

- By having access to IndividualRepresentation and Model embedded in major Vendor databases.
- By exchanging Consistent Models between vendors or research products
- By having the opportunity to participate to « well known » but today closed Geomodeling workflows.
- By having the opportunity to express the result of a Geomodeling workflow in a standard way and archive it for the future without « product versions numbers difficulties » ..
- By having the opportunity to develop and control new « Open Workflows » using a RESQML Standard EPC to progress Step by Step in the workflow by using the ACTIVITY MODEL

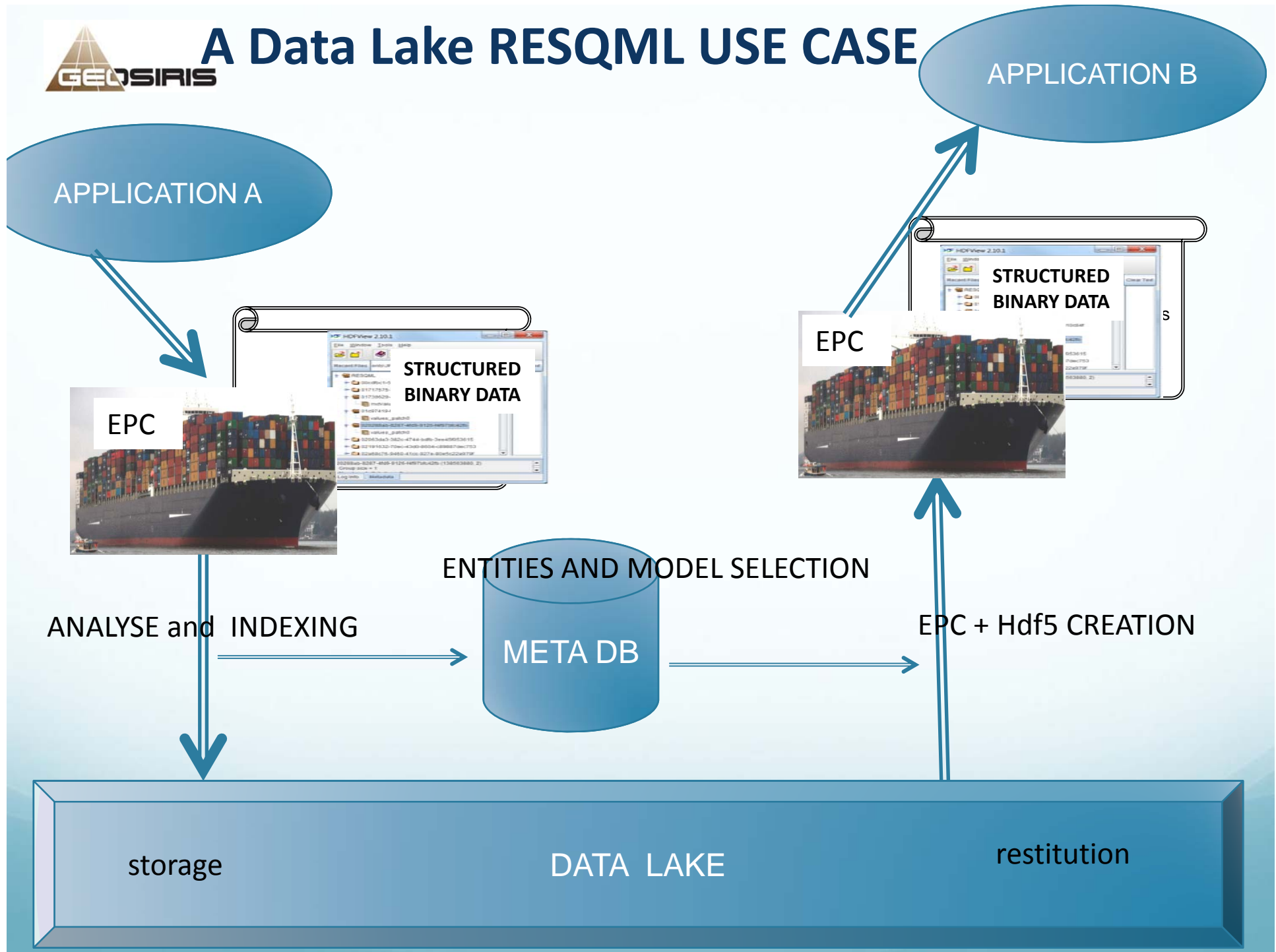


Secondly by joining Initiatives which will be launched in the next Future...

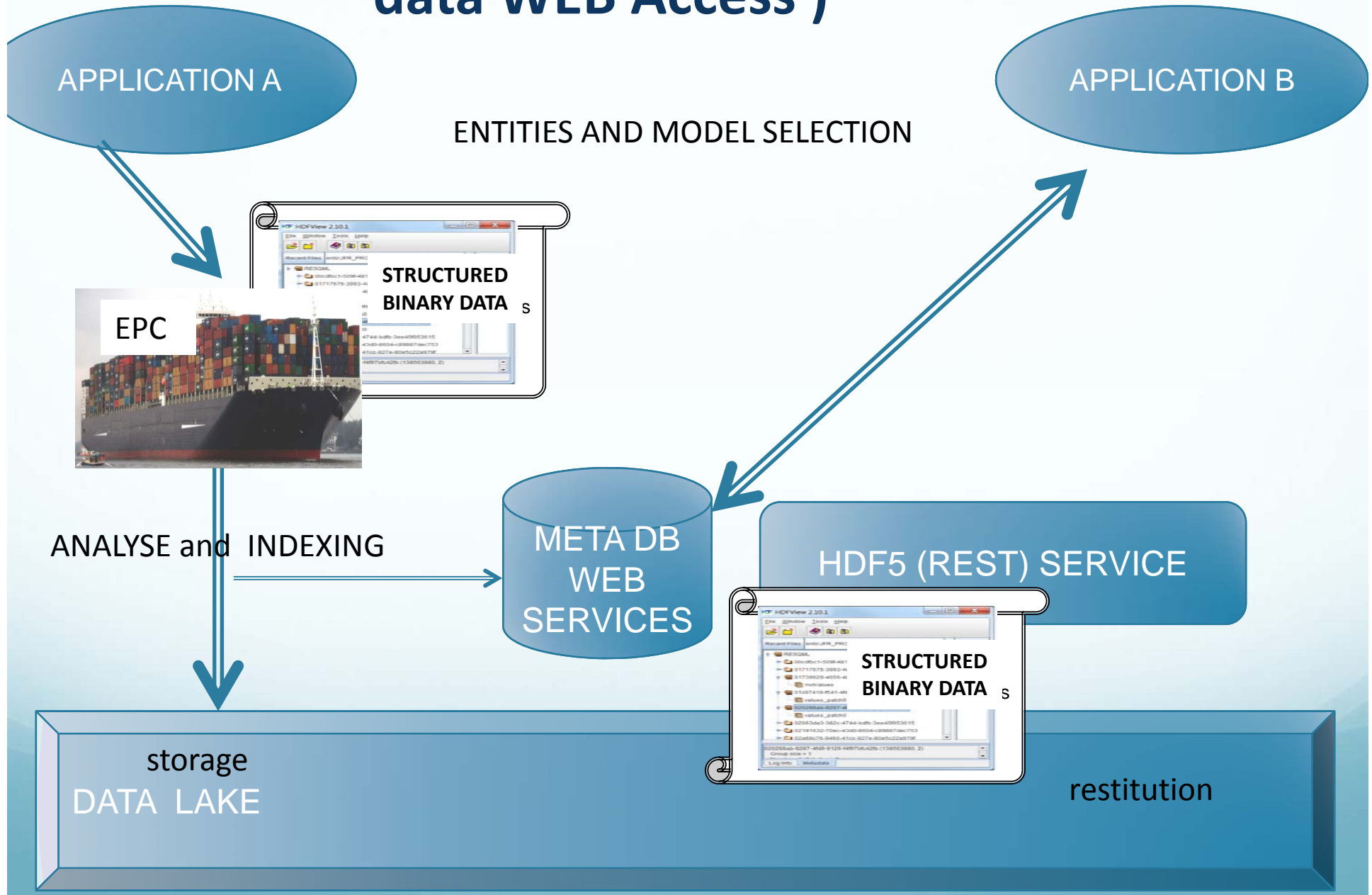
- First of all we can imagine a « Data Lake » as information repository about all the individuals feature and models of your survey : méta data, binary files, relationships and activities done.
- From the beginning of a study you can start to fill it dynamically up to the archive step.
- When you fill it you can set up a kind of Index for all these « Top level » entities together with a way to retrieve this information
- This could be a first usage : we are starting to experiment it .
- The second will be to organize a Work flow of semantic WEB services



A Data Lake RESQML USE CASE



One more RESQML USE CASE (data and meta data WEB Access)





Conclusion

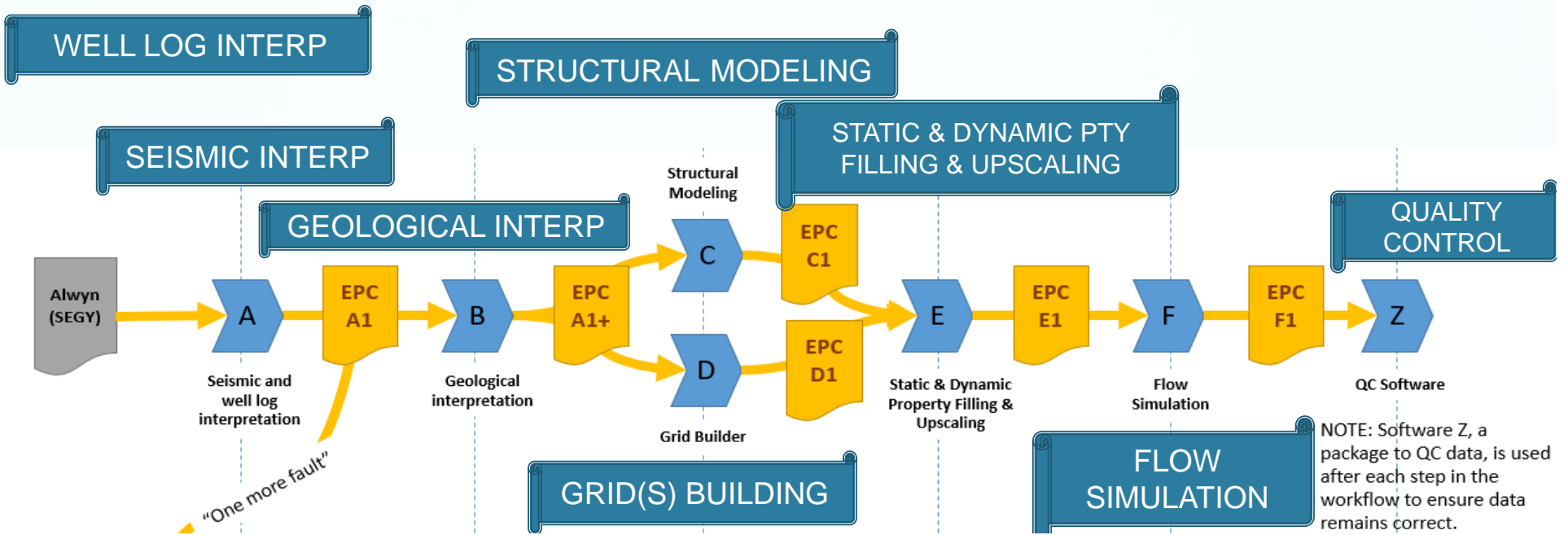
- More and more Use cases / Workflows of Geomodeling can be set up by using the RESQML Model
- Each of them can « liberate » the users from closed workflows or closed database management
 - For the data lake initiative you just have to manage what you deliver to the Data Lake and publish a RESQML epc that everybody could freely understand)
- Any type of Intelligent procedure (data mining, knowledge capture, knowledge extraction, knowledge diffusion) could be applied on the xml file « semantically designed » delivered in the datalake
- Then, we will be able to propose more and more capabilities to the users

On our side we are starting to implement some innovative initiative and we are ready to share technology and experience with the Geomodeling community.





EAGE 2017 : 1st Iteration of the Workflow presented (4 faults)



**Work flow followed for the first iteration:
Only 4 faults were considered**

RESQML data objects for easier transport.

+ Picked Fault

+ Interpreted Fault
+ "New" Structural Organization Interpretation

+ Updated Structural Framework
+ Updated Grid Structure

+ Updated Upscaled Grid
+ Updated Static Properties

+ Updated Dynamic Properties