GIS-BASED 3D GEOLOGICAL ANALYSIS TOOLS

Mar Alcaraz [a, b, c],   alcarazmar@gmail.com

Violeta Velasco [a, c],   viogeo@idaea.csic.es

Enric Vázquez-Suñé [a, c],   enric.vazquez@idaea.csic.es

[a] Institute of Environmental Assessment and Water Research (IDAEA), CSIC, c/ Jordi Girona 18, 08034 Barcelona, Spain

[b] Department of Geotechnical Engineering and Geosciences, Universitat Politècnica de Catalunya (UPC), Jordi Girona 1-3, 08034 Barcelona, Spain

[c] Associated Unit: Hydrogeology Group (UPC-CSIC)

INTRODUCTION

HYDROGEOLOGICAL MODEL

CONCEPTUAL MODEL ➡ ACCURATE

- Geological characterization
- Hydraulic characterization
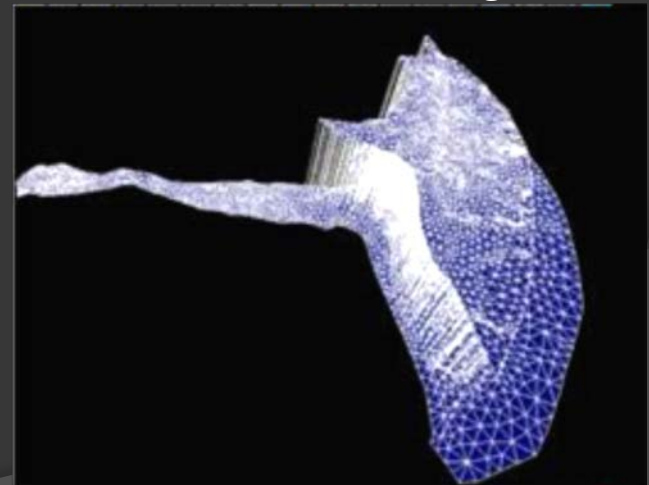- Hydrochemical characterization

Spatio-temporal data

⬇

Integration

⬇

Water Resources Management

BASIS FOR:

- Calculations and modelling
- Simulation of Scenarios/planning

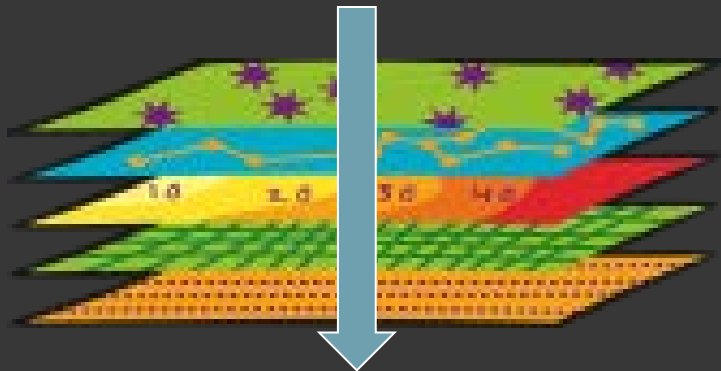*Model of Llobregat's Delta in Visual TRANSIN*

INTRODUCTION

SEDIMENTARY MEDIA → HETEROGENEOUS MEDIA

SIMPLIFY GEOLOGICAL MODELS
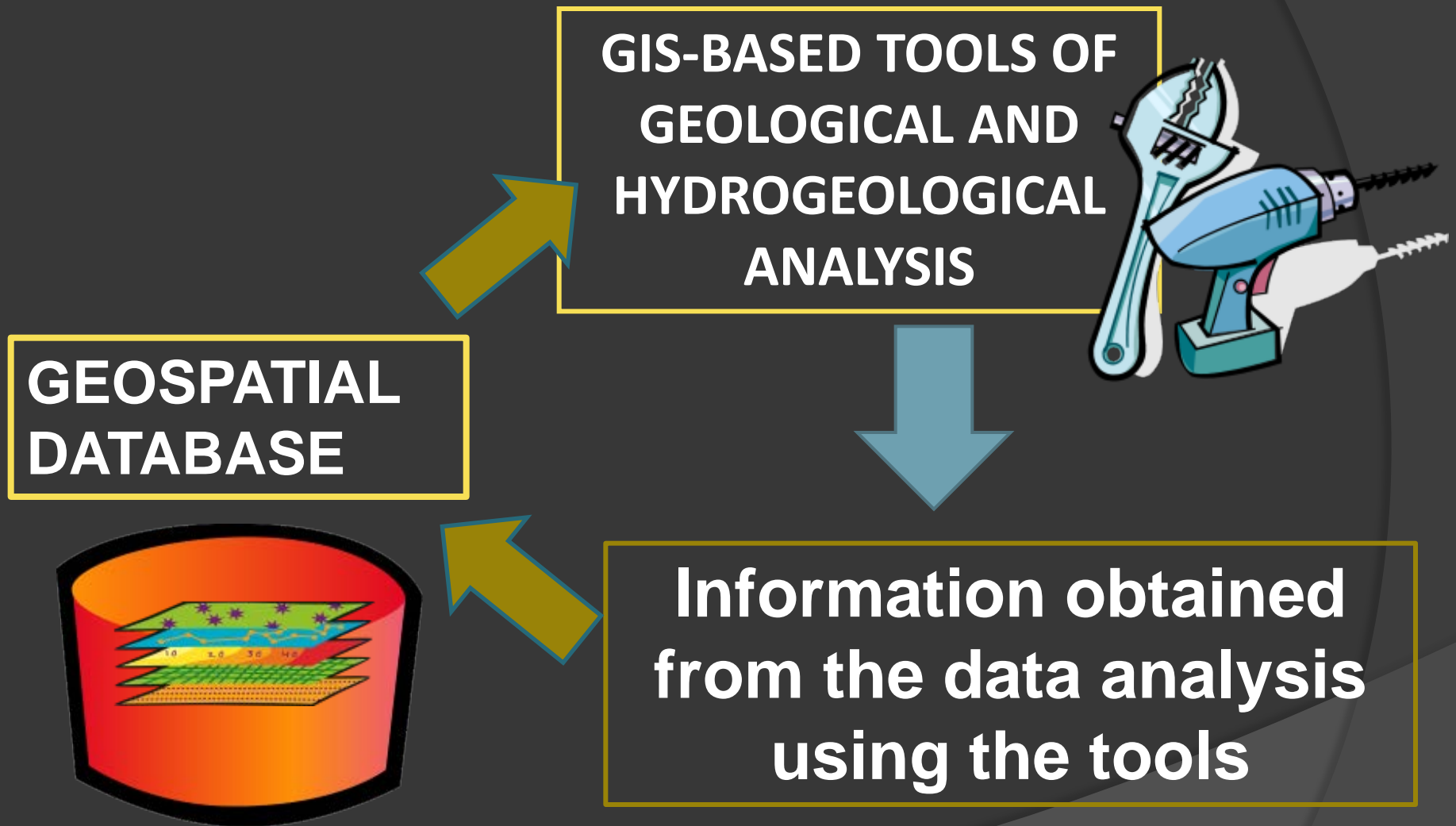

INNACURATE GEOLOGICAL MODEL

ACCURATE GEOLOGICAL MODELS

ACCURATE HYDROGEOLOGICAL MODEL
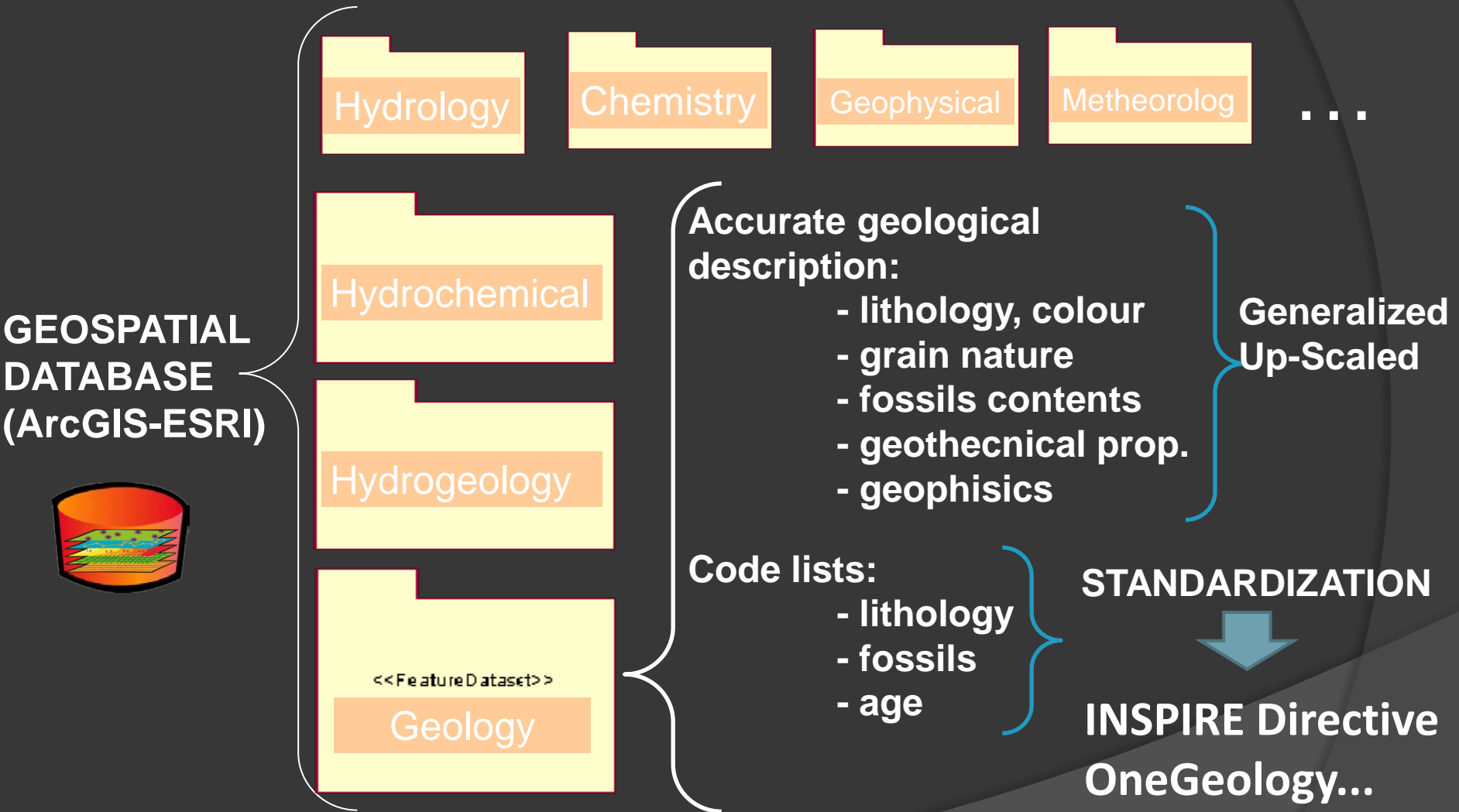
RELIABLE WATER MANAGEMENT

INTRODUCTION

➢ **Manage** and **integrate** a vast amount of data of all **kinds** (e.g. hydrological, geological, hydrochemical, etc).

➢ **Homogenize** and **harmonize** data collected from diverse sources gathered with different techniques.

➢ Communicate and exchange data of **different formats**.

➢ Manage data with **diverse temporal** and **spatial** ranges.

➢ **Handle** and retrieve **geological** and hydrogeological data to represent the **heterogeneity** of the aquifer systems in the **three dimensions** of space.

➢ **Integrate** the resulting **interpretations** and models with the necessary documentation for re-use by third parties for different objectives.
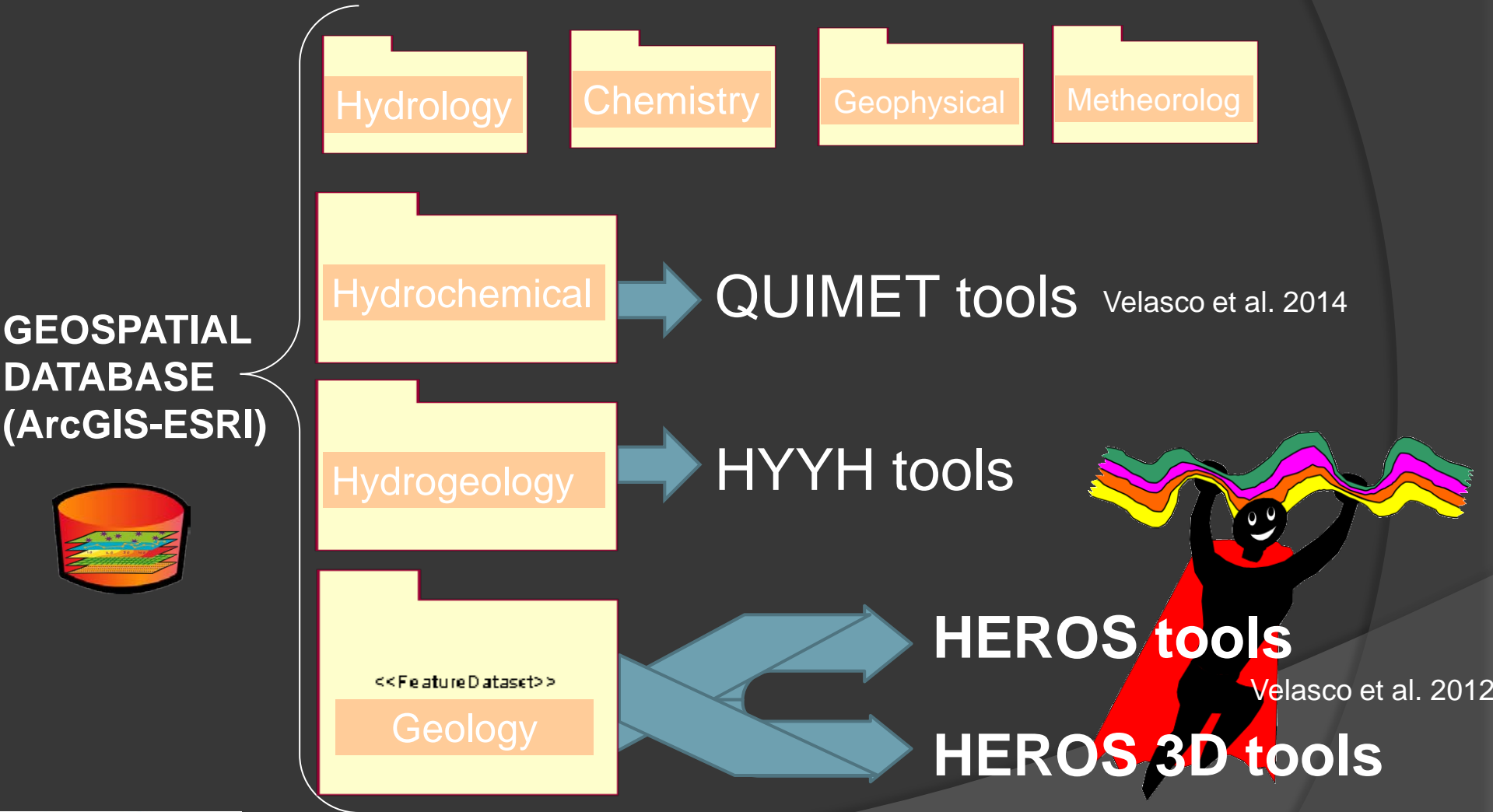
HYDROGEOLOGICAL FRAMEWORK

GIS-BASED TOOLS OF GEOLOGICAL AND HYDROGEOLOGICAL ANALYSIS

GEOSPATIAL DATABASE

Information obtained from the data analysis using the tools

HYDROGEOLOGICAL FRAMEWORK

Hydrology

Chemistry

Geophysical

Metheorolog

. . .

GEOSPATIAL DATABASE (ArcGIS-ESRI)

Hydrochemical

Hydrogeology

<<FeatureDataset>>

Geology

Accurate geological description:

- **lithology, colour**
- **grain nature**
- **fossils contents**
- **geothecnical prop.**
- **geophisics**

Generalized Up-Scaled

Code lists:
- **lithology**
- **fossils**
- **age**

STANDARDIZATION

INSPIRE Directive OneGeology...

HYDROGEOLOGICAL FRAMEWORK

Hydrology

Chemistry

Geophysical

Metheorolog

GEOSPATIAL DATABASE (ArcGIS-ESRI)

Hydrochemical → QUIMET tools Velasco et al. 2014

Hydrogeology → HYYH tools

<<FeatureDataset>>

Geology → HEROS tools

Velasco et al. 2012

HEROS 3D tools

Velasco, V., Tubau, I., Vázquez-Suñè, E., Gogu, R., Gaitanaru, D., Alcaraz, M., … Sanchez-Vila, X. (2014). GIS-based hydrogeochemical analysis tools (QUIMET). *Computers & Geosciences*, *70*, 164–180. doi:10.1016/j.cageo.2014.04.013

GEOLOGICAL TOOLS

Parametrize hydrogeological properties and geometry

ArcMap 10

HEROS tools

Velasco et al. 2012

Parametrization and 2D – 3D **interpretation**

GDB

HEROS 3D TOOLS

3D Visualization and autogeneration

ArcScene 10

- ❑ **Stratigraphic columns** (lithology, sedimentary structures, units..)
- ❑ Geological **profiles**
- ❑ 2D - 3D Interpretation
- ❑ Hydraulic parametrization

- ❖ Work with 3D surfaces
- ❖ 3D representation of boreholes
- ❖ Create fence diagram

Velasco, V., Gogu, R., Vázquez-Suñè, E., Garriga, a., Ramos, E., Riera, J., & Alcaraz, M. (2012). The use of GIS-based 3D geological tools to improve hydrogeological models of sedimentary media in an urban environment. *Environmental Earth Sciences*, *68*(8), 2145–2162. doi:10.1007/s12665-012-1898-2

HEROS TOOLS

(1)Borehole diagram

Visualization and analysis of the detailed geological core description of the borehole.

Classic working environment the geologist.
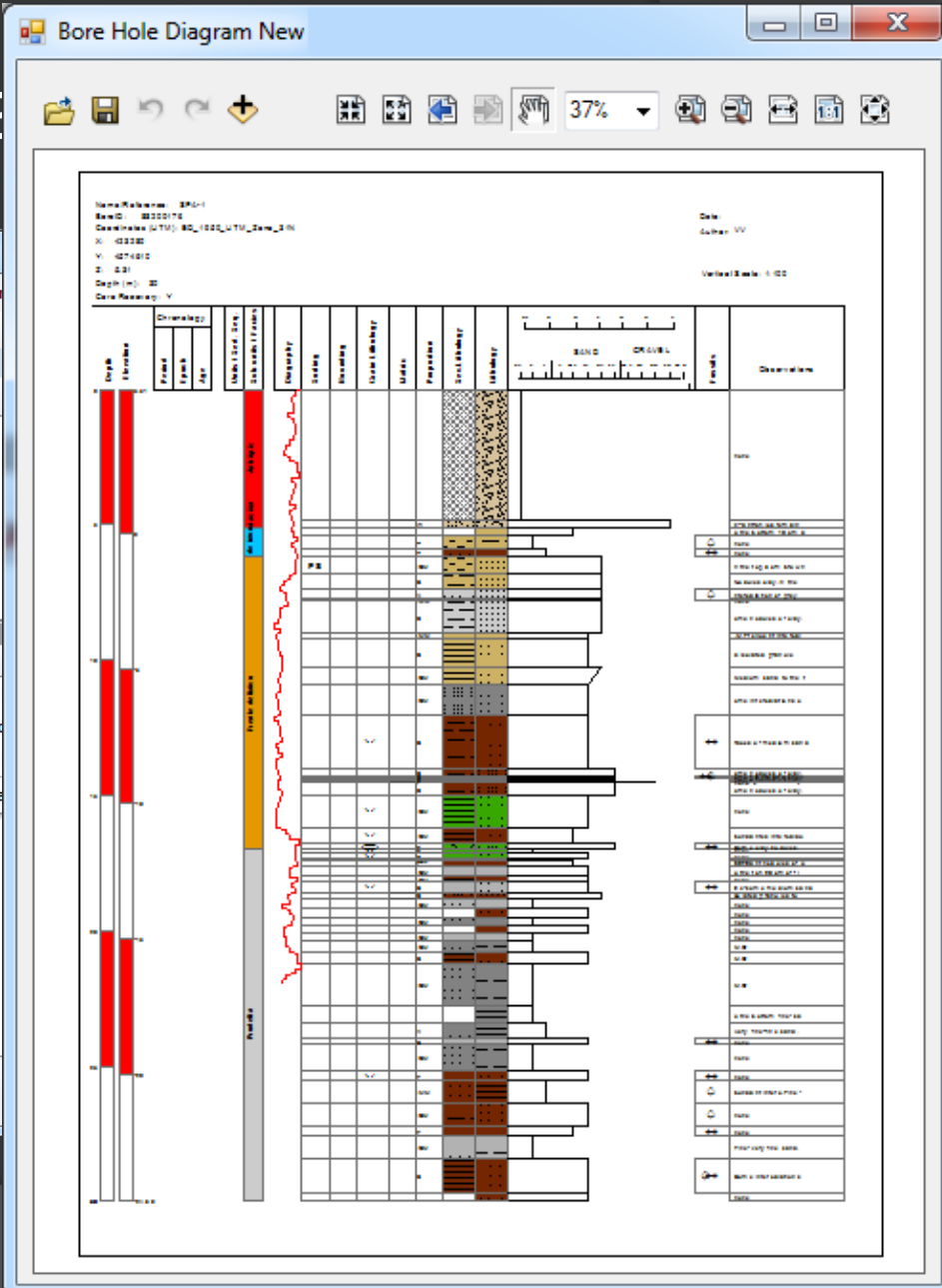
HEROS TOOLS

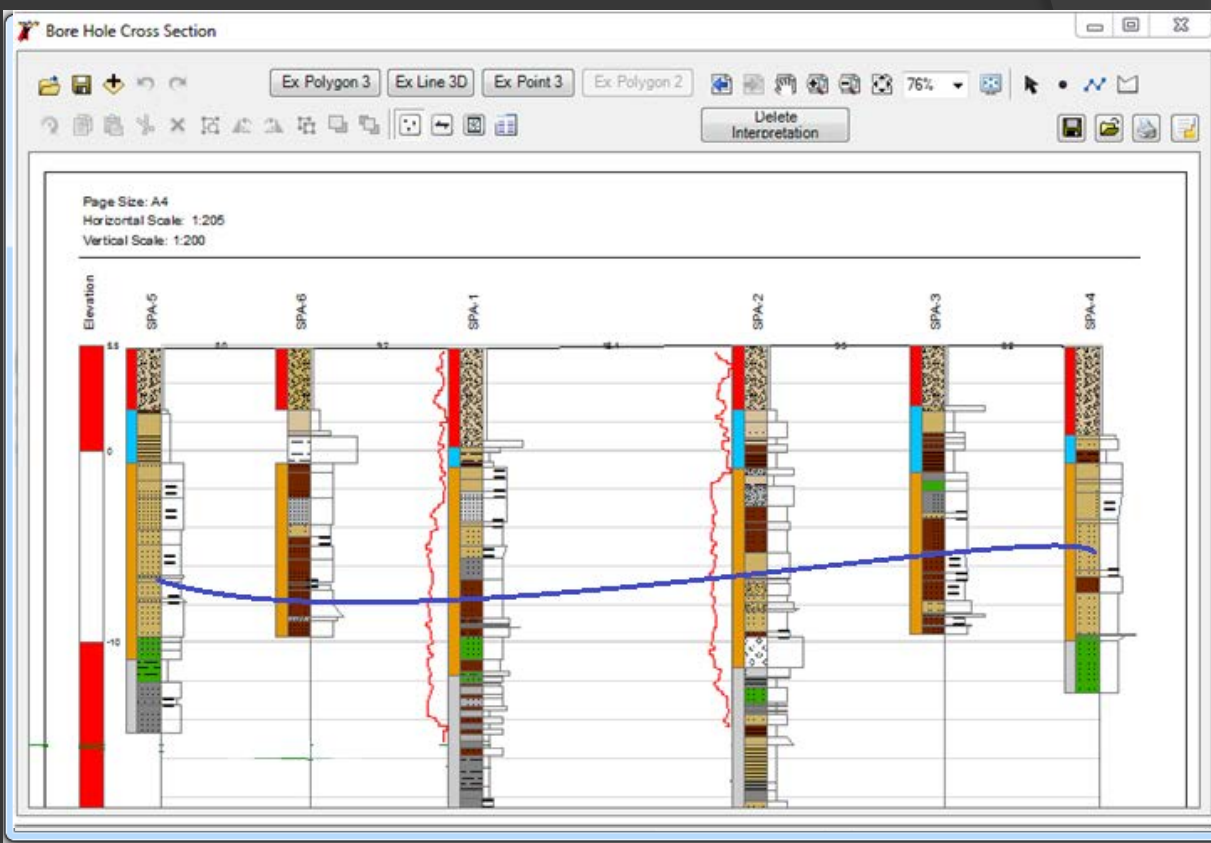## (2) Stratigraphic cross-sections correlation toolset.

Creation of a geological profile.

- -Selected buffer distance.
- -Projected or not projected.

Previous surfaces interpretated

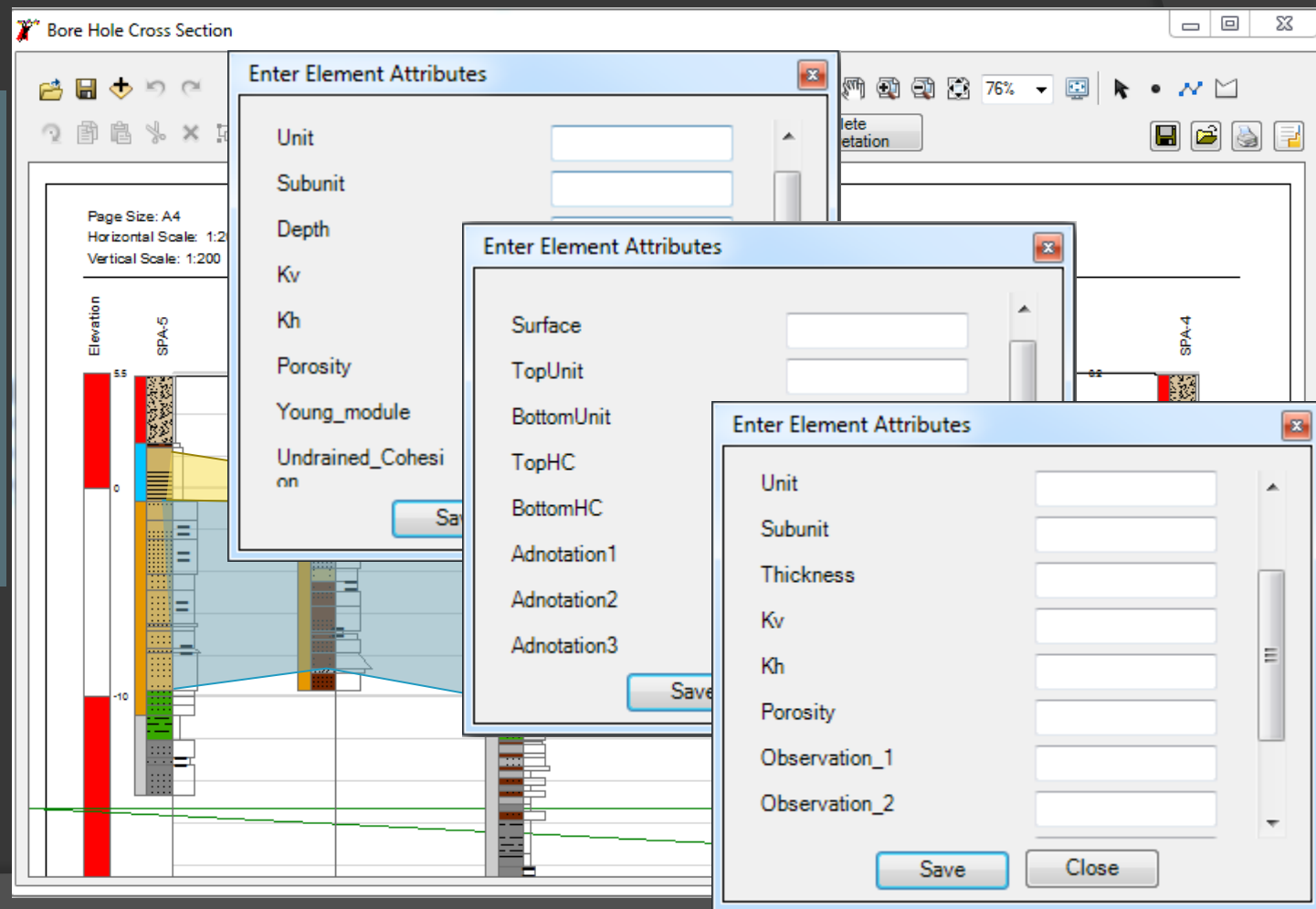Topography and geological outcoups
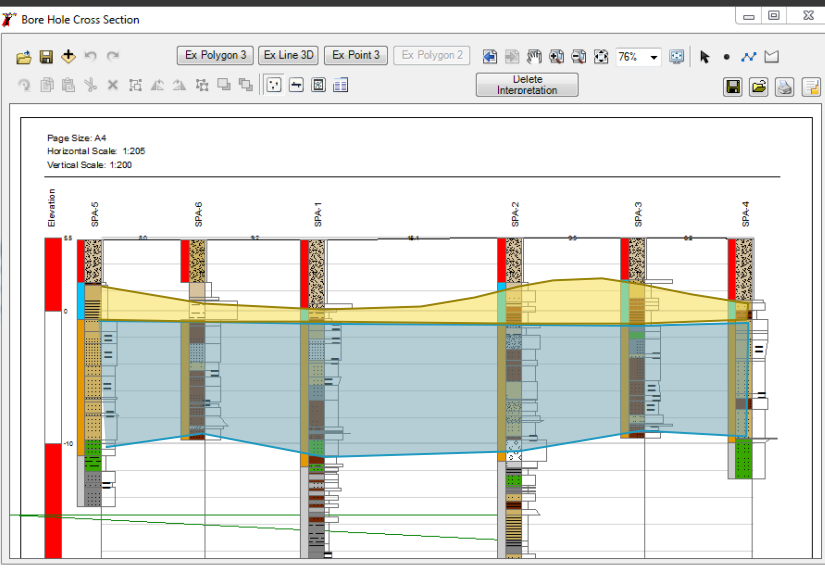
Intersection with previous surfaces

HEROS TOOLS

(2) Stratigraphic cross-sections correlation toolset.

- **Interactive analysis environment**
- **Definition units, facies..**
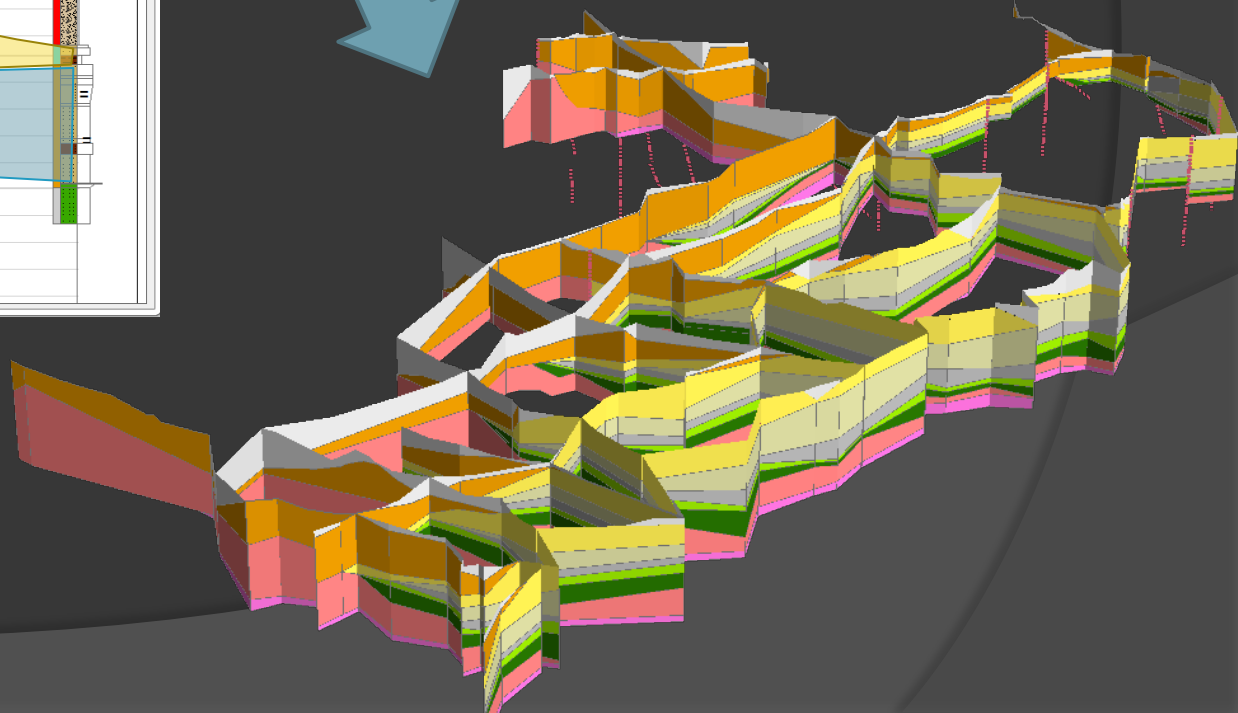- **Interpreted data to database**
- **Documentation in atributes**

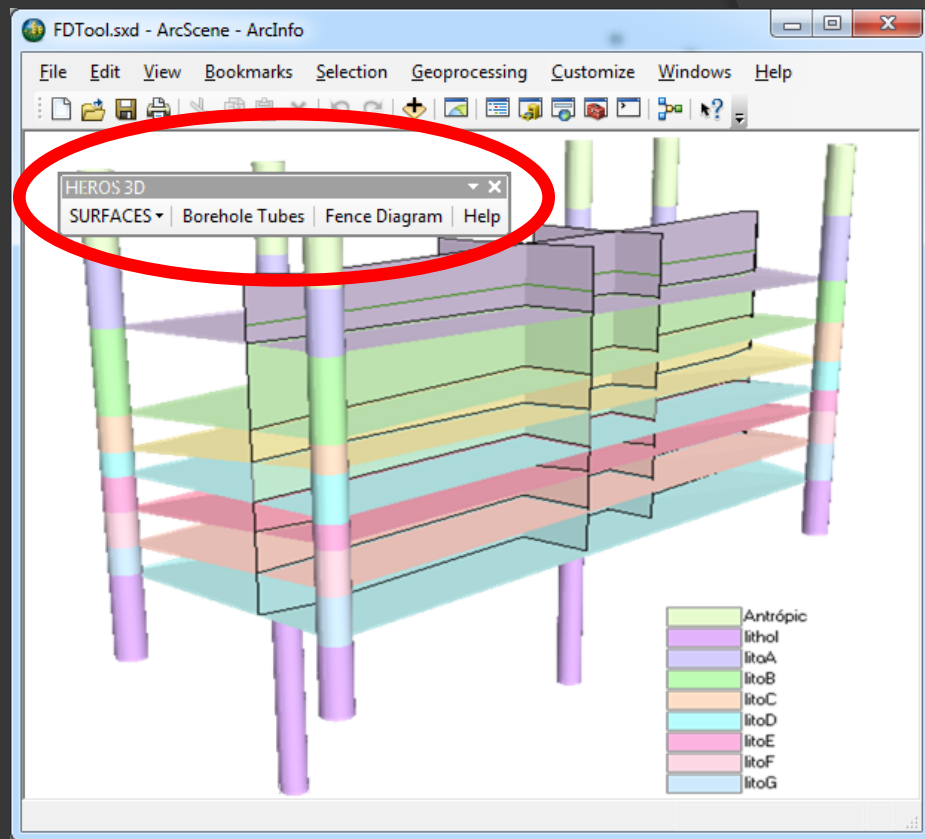# (2) Stratigraphic cross-sections correlation toolset.

ArcSCENE

HEROS 3D TOOLS

3D visualization of the interpretation
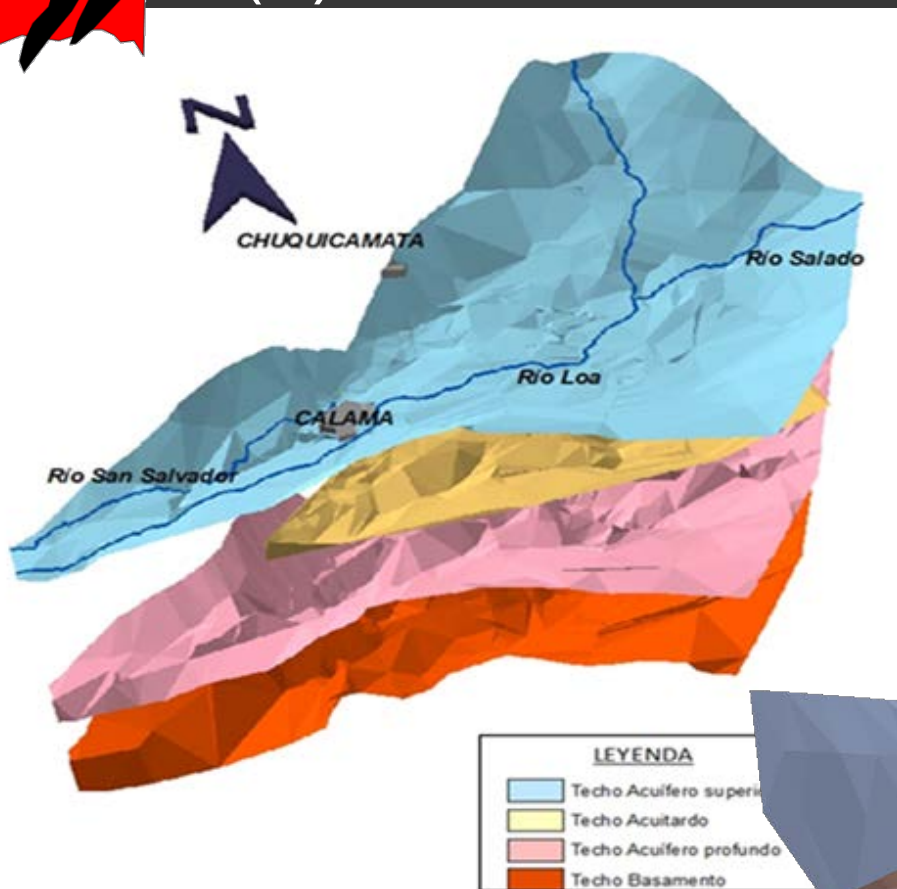generated by HEROS

HEROS interpretation

HEROS 3D tools

(1) Surfaces toolset

(2) Borehole tubes tool

(3) Fence diagraman tool

HEROS 3D TOOLS

(1) SURFACES TOOLSET

(1.1) Surface from interpretation tool
        -contact surfaces
        -linear interpolation
        -initial version of the model

(1.2) Extend surface tool
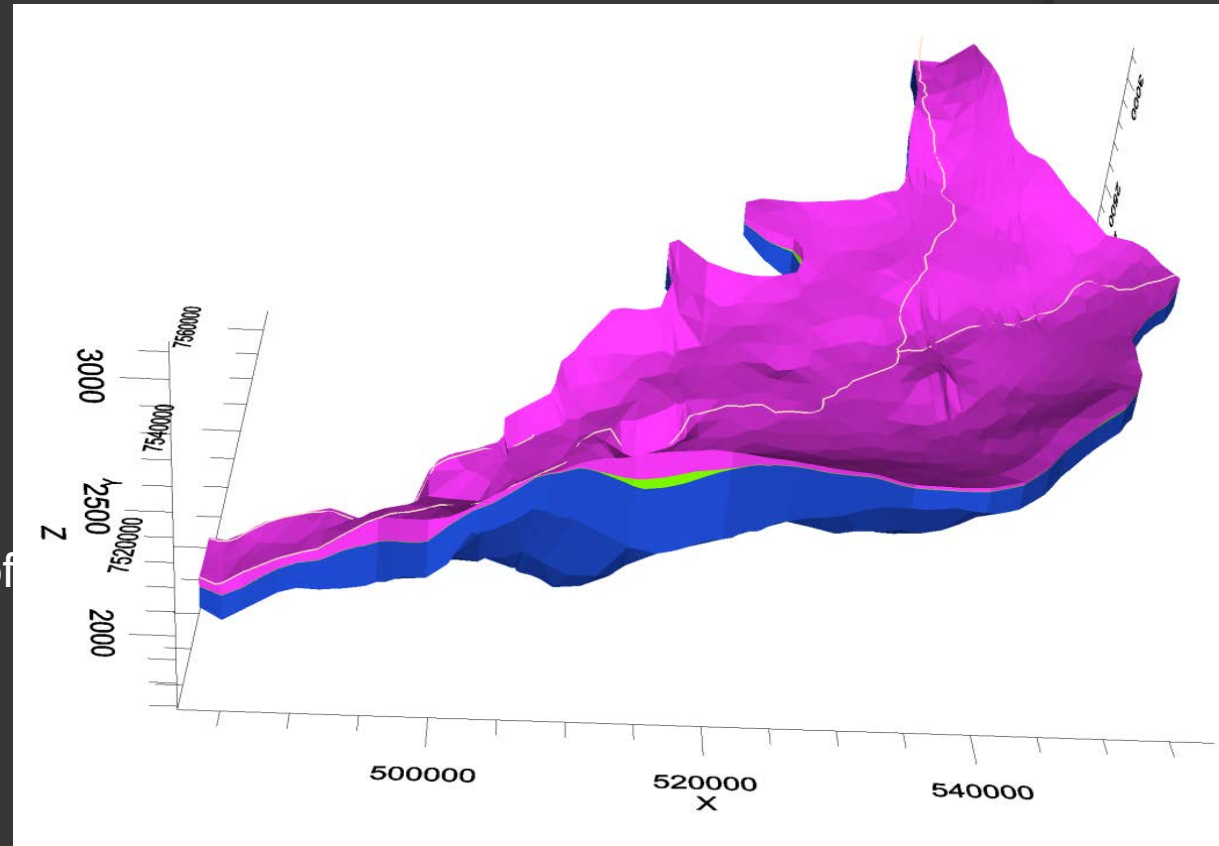   **- cover entire domain**
(1.3) Intersect surfaces tool

HEROS 3D TOOLS

Comparison of existing interpretation

Validation of the generated surfaces

Integration with other layer of information (piezometry…)
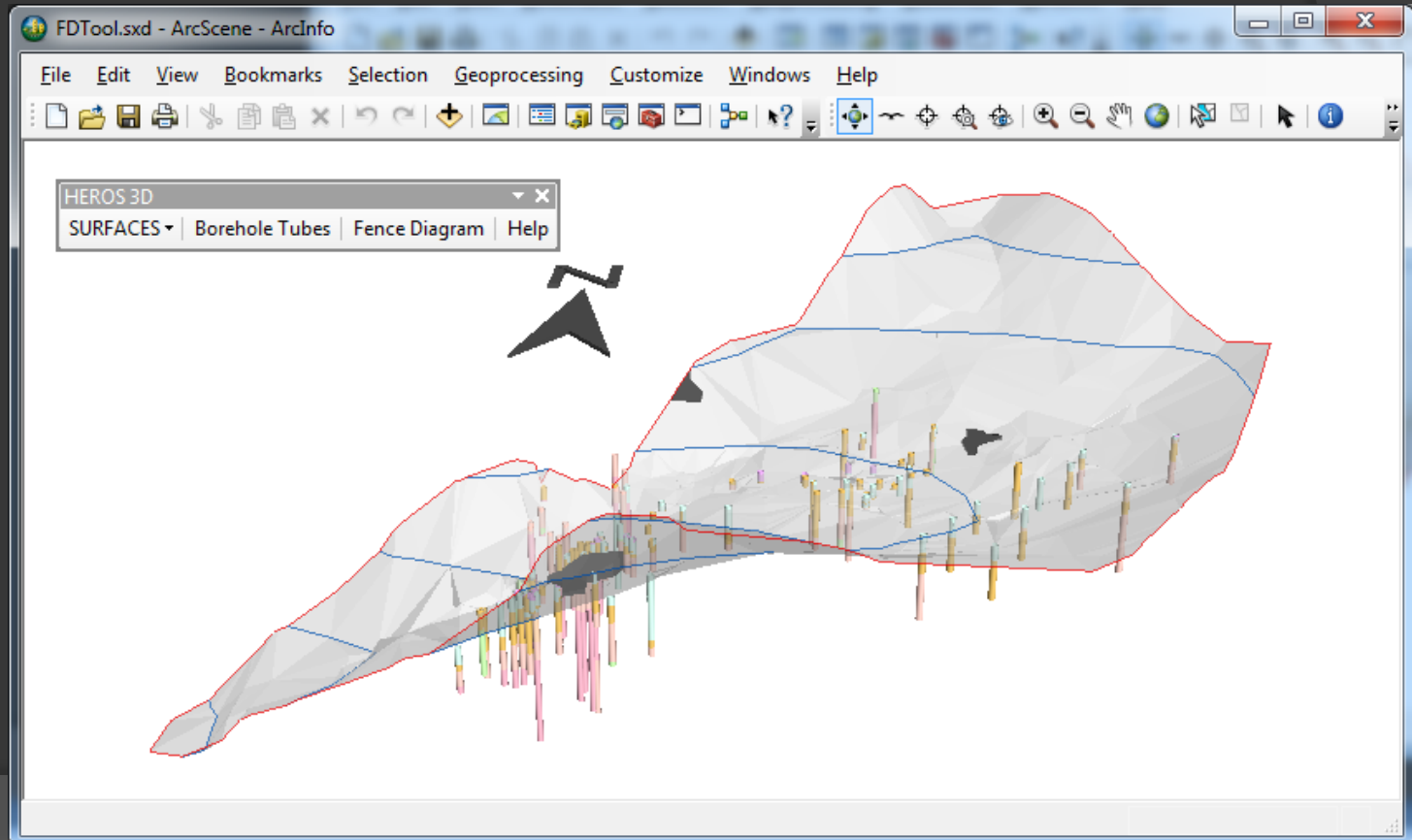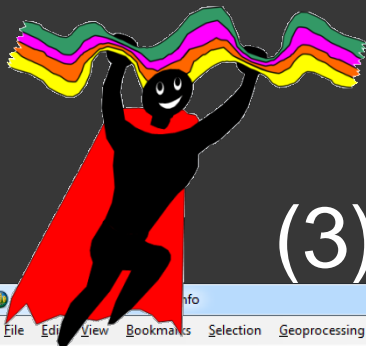
Export to hydrogeological numerical software

HEROS 3D TOOLS

(2)BOREHOLE TUBES TOOL

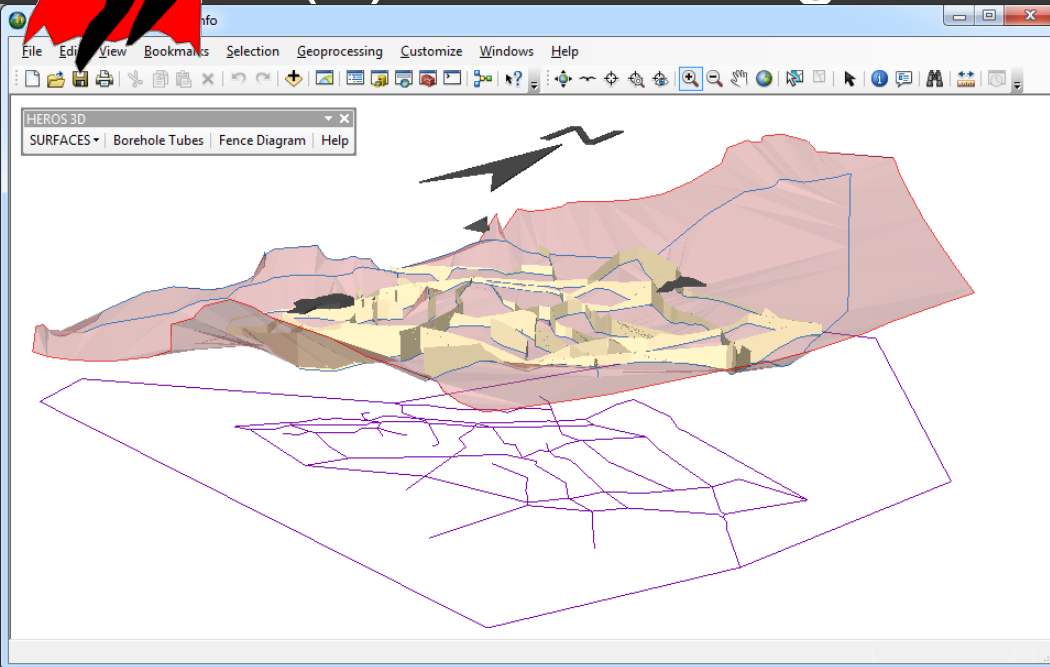3D representations of the geological interpretation
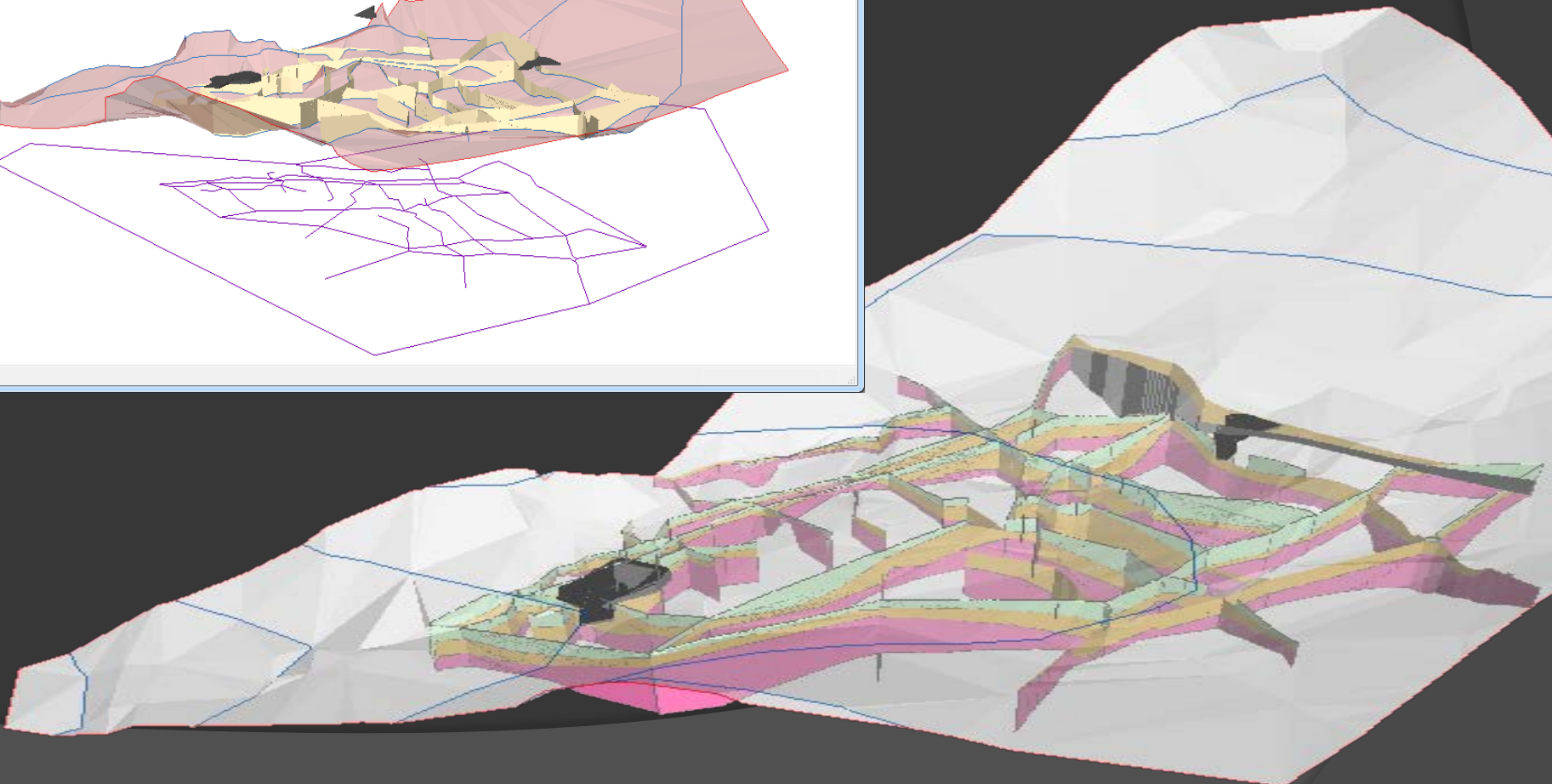
Diameter size defined by the user

HEROS 3D TOOLS

(3) Fence diagraman tool

Automatical generation of fence diagram

CONCLUSIONS

- This software platform offers a working environment for managing, querying and interpreting data in a **3D GIS environment**.

- The geospatial database allows us to **store and manage data** from most hydrogeological and geological studies. Additionally the possibility of **querying and visualizing** all the available information in the same 3D environment give us the possibility of **integrate** the geological information with other relevant data and thus to obtain further information.

- Apart from the database, the presented platform offers a great variety of **automatic tools** developed in ArcScene (ArcGIS;ESRI) designed to exploit the stored data. Using these tools with the rest of ArcScene capabilities increases the functionability of the software, which provide a **comprehensive geological analysis** and a subsequent **3D geological modelization**.