

## Short Description

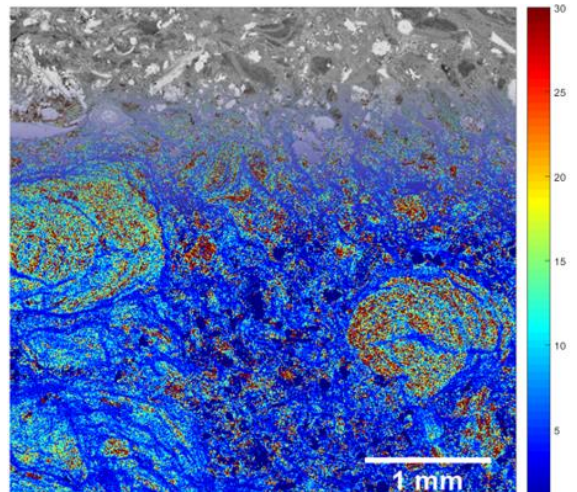
PLANE (Petrophysical **A**nalysis Based on Image Exploration) is our full digital **Physics Driven** solution for rock properties determination. It is based on multiphysics imaging of lithological material and the application of petrophysical/mechanical models to the acquired image data for rock characterization.

## Deliverable

- Images (SEM, Light, EDS, SAM, Nanoindentation).
- Mineralogy, Porosity, Permeability, Pc Curves, Vp/Vs and Young Modulus [Current Version]
- Outputs as scalars, distributions, physical correlations and rock typing as spreadsheets and .las files if vertical profiling is requested

## Benefits

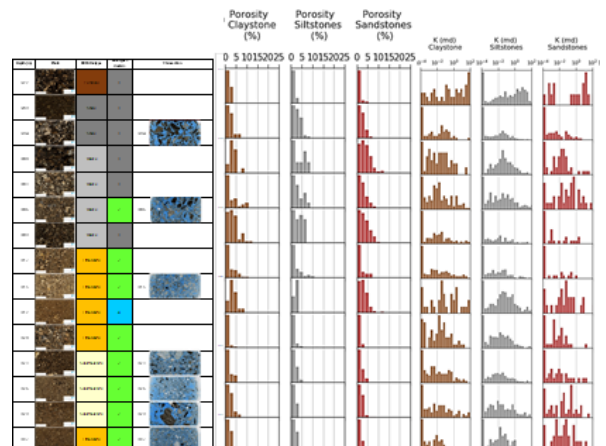
- Reduce reservoir model uncertainty allowing to have a better understanding of resources in place.
- Increase the quality of reservoir static model by incorporating data from all the wells
- Allow reservoir characterization (Geology, Petrophysics and Rock Mechanics) where coring and/or Side Wall Cores are not available or feasible.
- Cost/time-effective analytical approach (60% cost and 80% time less than conventional experimental approach).
- Multi-point/sample report for improved property understanding and uncertainty quantification



Example of PLANE[TechLab] technology application to thin sections (PLANE[THIN]). A permeability map (colored in mDs, bottom) computed from SEM image (gray scale, top) on a tight carbonate sample.

## Differential Features

- Faster and cheaper than tomographic standard (in plugs).
- Applicable in all rock samples even cuttings.
- Geological properties based on digital technologies not available commercially.
- Anisotropy studies can be done using tomographic datasets.
- Unique Installed Imaging Infrastructure (including acoustic microscopes and nano-indentation systems).
- Only target samples (plugs, thin sections and cuttings) are needed, no additional data or type of sample.



Example of PLANE[TechLab] technology application to cuttings (PLANE[CUTTING]). Synthetic logs with Geological (left) and windowed Digital Rock Physics properties (center and right), per lithology and properties distributions.



## Requirements

- Lithological material as: Plugs or miniplugs, thin sections, cuttings or rock fragments.
- Perfect, lab suitable Plugs/SWC are not needed, even broken ones or with any diameter can be tested.
- For cuttings samples: wet (250 grs) or dry (50 grs).
- Samples depth shift as accurate as possible.
- Definition of reservoir interest interval.

## Limitations

- Not recommended for samples with predominant pore sizes below 0,01um.
- Dry cuttings reduce cost and results time to customer.
- Non suitable for powdered drill cutting samples.
- As based on image analysis, proper resolution (REA), contrast, artifacts handling and signal/noise ratio should be reached in image quality (this is significant if working with external contractors inputs is required).
- Some calibration points are suggested for some environments to improve output accuracy.

## The Product in Depth

PLANE is based in the analysis of high resolution multi-physics imaging on lithological material prepared as quality thin sections or fragments for tomographic data. Depending on customer needs and characteristics several high resolution images are obtained using specifics instrumentation. Several thousands of numerical parameters are measured in every single image leading to a comprehensive set of physical measurement (i.e. mineral composition, porosity, pore throats, Young modulus, among many others). The reservoir and or any other properties (i.e. Permeability,  $Sw_{irr}$ ,  $P_c$ ,  $VP/VS$ ) are directly calculated by the application of one or several physical models fed by the several parameters previously extracted from the images. In order to help a higher customer audience we have developed specific solutions targeting different lithological materials origins.  $PLANE_{[PLUG]}$  is our solution for plugs and SWC's (even broken or not lab suitable).  $PLANE_{[THIN]}$  is an optimized product for rock characterization from thin sections.  $PLANE_{[CUTT]}$  is our state of the art solution to provide petrophysical and mechanical rock properties from the more ubiquitous and less spatial biased cutting materials. As a Physics Driven solution, results can be analyzed to provide deeper insights about reservoir behavior.

## Some Use Cases

Use Case / Model	Client	User	Cost (K€)	TimeToMk (m)
<i>Anisotropy study based on porosity, capillary pressure and permeability evaluation including Thomeer parameters and Prob. Dens. Functions (PDF). 7 plug samples; 2019.</i>	• Oil Search (Alaska)	• Petrophysicist • Reservoir Geomodeller	34	1.5
<i>Porosity and permeability characterization to be used as a reference in future horizontal wells; 2020</i>	• Norway (Yme)	• Petrophysicist • Reservoir Geomodeller	75	2,5
<i>Reservoir characterization in turbiditic sandstones. Identification of diagenetic processes affecting reservoir quality heterogeneity and uncertainty; 2020</i>	• GOM (Buckskin)	• Petrophysicist • Reservoir Geomodeller	75	2,5

