HELLENIC REPUBLIC
MINISTRY OF DEVELOPMENT AND INVESTMENTS
GENERAL SECRETARIAT FOR RESEARCH AND INNOVATION

FORTH
FOUNDATION FOR RESEARCH & TECHNOLOGY - HELLAS
INSTITUTE OF GEOENERGY

OIL & GAS
UPSTREAM SERVICES

INSTITUTE OF GEOENERGY

ITE
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Based in Chania (Crete, Greece), the **Institute of GeoEnergy** of the **Foundation for Research and Technology– Hellas (FORTH/IG)** is oriented towards basic and applied research on energy exploration and production, as well as on energy transition; with the latter focusing on green energy, environmental sciences and reduction of the conventional fuel's carbon footprint. Initially established as Institute of Petroleum Research (FORTH/IPR), was later renamed to Institute of GeoEnergy (FORTH/IG).

The strategic goal of FORTH/IG is to become a reference point for the Eastern Mediterranean region, in the field of sustainable development and exploitation of energy resources.

Among the basic principles of the Institute are the excellence, the innovation, the documented accuracy of its views, the quality and stability of energy supply, the environmental protection and responsibility, and the continuous effort to improve the conditions of human life in society in the most sustainable way.

The three main directions of research at FORTH/IG are :

Fossil Fuels and Carbon Management

Oriented to the research and development of methods and techniques for the exploration of geological formations, suitable for the generation and production of organogenic energy resources, the development of innovative methods for their production and transportation, the production of conventional fuels with minimal carbon footprint and the development of technologies for carbon dioxide capture and storage.

Environment and Circular Economy

Oriented towards studying and developing innovative methods and techniques to address the environmental impact of the energy resources' exploitation. It also aims at the development of materials and energy reuse technologies and the elaboration and risk assessment in environmental studies.

Green Energy

Oriented towards the development of innovative technologies related to the reduction of the carbon footprint of the energy mixture using hydrogen, geothermal energy, green fuels (biogas, methanol, ethanol, ammonia) and the optimization of the structure and operation of energy systems.

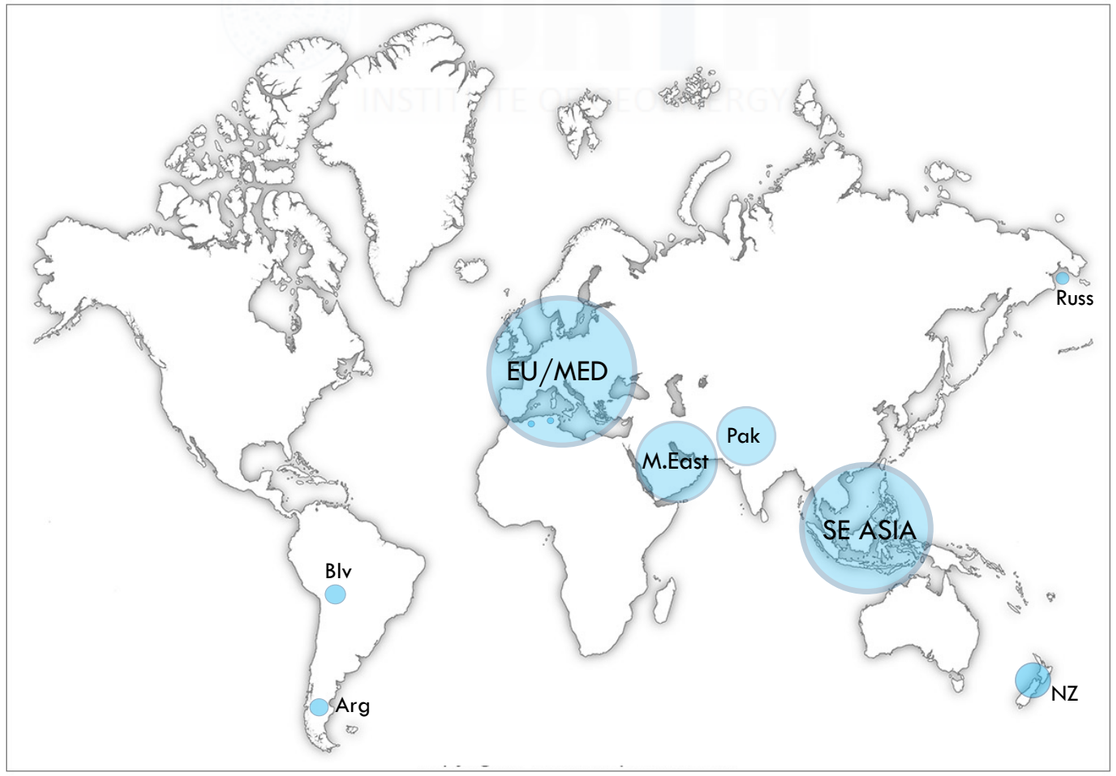
A New Pole for Research and Innovation in the Eastern Mediterranean

ΙΝΣΤΙΤΟΥΤΟ ΓΕΩΕΝΕΡΓΕΙΑΣ

FORTH INSTITUTE OF GEOENERGY

FORTH/IG premises hosted in Technical University of Crete Campus

We are specialized in developing, testing, implementing and defining exploration opportunities, new play concepts and new guidelines in terms of risk and resource assessment for an exploration policy and an optimization of existing fields.



Map showing FORTH/IG's worldwide experience

The Institute of GeoEnergy (FORTH/IG) is recognised as one of the industry leading experts in G&G studies, Geochemical evaluation and Basin and Petroleum Systems Modelling (BPSM) in the Eastern Mediterranean - with over 70 years of cumulative experience developing a deep understanding and breadth of knowledge of many geological settings worldwide.

FORTH/IG's focus on integration of G&G-Geochemistry with BPSM helping clients to better understand their petroleum systems, from the molecular to the tectonic scale.

An intensive international experience with petroleum industry problems and experience working with industry data for structural analysis in complex setting associated to reservoir characterizations (interaction fluid-rocks vs tectonic).

Highly qualified expertise with seismic and subsurface data interpretation: integration of tectonic, stratigraphy/sedimentology, seismic and subsurface data with strong geological database management.

Worldwide intensive experience in the assessment of Oil and Gas plays, and in providing both transparent and open-source oil and gas lab services.

The researchers, associates and consultancy staff are highly qualified in geological, geophysical and both geochemical interpretation and basin modelling methods.

FORTH/IG's services are focused primarily on assessing and modeling the sedimentary basin, and to define its physical and chemical characteristics through time and space; with the aim of identifying, mapping and ranking potential subsurface areas for hydrocarbon generation and accumulation.

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EXPLORATION SERVICES

We provide consultancy services to petroleum and energy companies, government institutions and non-governmental organizations...

- Structural Analysis & Seismic Interpretation
- Stratigraphy , Biofacies & Sedimentology
- Forward Kinematic and Stratigraphic Modelling
- Petrophysics & Rock-physics
- Integrated G&G Play Assessment Workflow
- Seismic Characterization
- Organic Geochemistry & Petrography
- Petroleum Systems & Basin Modelling
- Geological Plays Risk Assessment

FORTH/IG offers services to any requirements you may have, from regional assessments of permit areas to post drill analysis on your well.

Seismic Interpretation & Frontier Basins Exploration

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Geophysics, such as seismic, are crucial to image subsurface.

Our services and expertise include:

- High-quality seismic data processing at an affordable price.
- 2D and 3D seismic and structural interpretation.
- High resolution mapping vs multiple attributes.
- Time-depth conversion, velocity modelling and static geomodelling for upscaling to reservoir modelling.
- Integration of seismic data with well-logs, core, petrophysical and biostratigraphic data.
- Evaluation of prospects and leads for farm-in and exploration projects.

Stratigraphy and Well Correlation

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Understanding of the stratigraphic framework is fundamental to any study.

Our services and expertise include:

- Outcrops analysis - connecting analogues to offshore E&P well data.
- Stratigraphy to seismic integration: well data integrated to the seismic dataset and main key horizons interpretation.
- Local and regional sequence stratigraphic interpretations - reconstruction of burial history and basin evolution and identification of main reservoirs.
- Integrating biostratigraphy, lithostratigraphy and seismic stratigraphy with wireline logs, cuttings and core interpretation.
- Subsurface characterisation - identification of main potential source rocks, reservoirs, seals.
- Well to seismic ties - lithostratigraphic, biostratigraphic and chronostratigraphic well tops tied to the seismic data.

Conventional Core Studies

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Core studies are crucial for tracking reservoir behavior.

Our services and expertise include:

- Core description - trace fossils, colours, fractures and facies interpretations, grain size, lithology, sedimentary structures, bioturbation index.
- Reservoir heterogeneity analysis - correlated with wireline logs, image logs and biostratigraphy, to refine previous regional stratigraphic models.
- Facies analysis is an important input for 3D reservoir modelling to better characterise sandbody and/or seal geometries.
- Seal quality and variability of core samples.
- Reservoir quality assessment - rock texture, composition, pore systems, petrography, diagenesis, etc.
- Fluid rock interaction and diagenetic modelling correlated with basin and hydrocarbon generation models.

Borehole Imaging

FORTH
INSTITUTE OF GEOENERGY

To recognise geological features within an image.

Our services and expertise include:

- Raw data QC and image processing.
- Structural analysis - in-situ stress assessment and fracture characterisation with core integration.
- Sedimentological analysis integrated with core and/or biostratigraphy.
- Qualitative identification of permeability barriers, porosity and calculation of net:gross.
- Calibration with core, outcrop data, conventional logs and seismic.

Biostratigraphy

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Biostratigraphy is the most reliable and cost-effective way of dating sedimentary strata and interpreting depositional conditions.

Our services and expertise include:

- Biostratigraphic, paleoenvironmental and biofacies analysis.
- During drilling - micropaleontological age control and biosteering on top of stratigraphic reviews of well and outcrop successions.
- Regional correlations of well data for basin analysis.

Structural Modelling

FORTH
INSTITUTE OF GEOENERGY

Predicting petroleum generation and migration in your prospects for structural modelling, basin modelling and reservoir characterisation.

Our services and expertise include:

- 2D forward and reverse modelling.
- Data collation - interpretation of data, seismic, well, field, and image formats.
- Geological section construction - depth conversion, well and dip projection, stratigraphic correlation, seismic restoration and burial history and fault and bed construction.
- Restoration and 2D forward modelling through isostasy, decompaction, unfolding/un-shearing, shearing, block restoration.
- 2D section construction, validation and structural analysis.

Petroleum Geochemistry

FORTH
INSTITUTE OF GEOENERGY

Minimising petroleum charge risk in your prospects.

Our services and expertise include:

- Analysis and interpretation of kerogen type, quality and maturity.
- Kinetics of main source rock formations - providing bulk and compositional kinetic parameters for petroleum systems analysis and basin modelling.
- Identification of migrated oil in cores.
- Analysis and interpretation of biomarkers.
- Analysis and interpretation of hydrocarbon and isotopic compositions.
- Oil–oil and oil–source rock correlations.

Basin Modelling

FORTH
INSTITUTE OF GEOENERGY

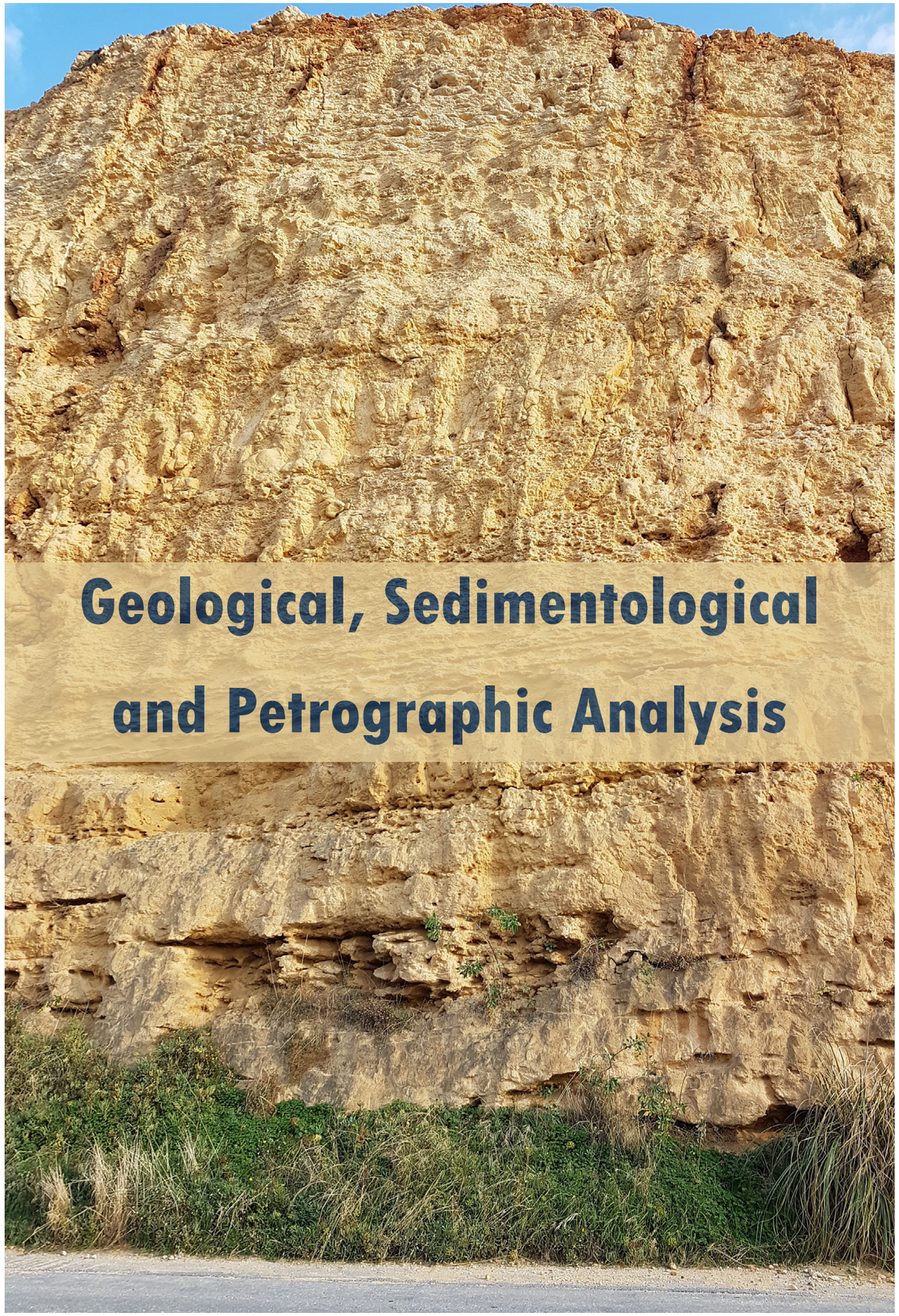
Predicting petroleum generation and migration in your prospects.

Our services and expertise include:

- Assessment of kerogen type and maturity, and oil-source rock correlation.
- Heat flow reconstruction vs tectono-stratigraphic setting and detailed thermal history modelling of sedimentary basin.
- Prediction of the most relevant timing and amount of oil and gas generated and expelled from source rocks.
- 1D, 2D or 3D petroleum systems modelling and exploration risk assessment from basin to prospect scale.
- Analysis and interpretation of fault and top-seal efficiencies as well as leakage of hydrocarbons and overpressure analysis.

Lab Services

- Geological, Sedimentological & Petrographic Analysis
- Routine Core Analysis
- Fractures Analysis (Whole-Core)
- Organic Geochemistry
- Special Core Analysis
- Kinetics of Source-Rock



G1. Sedimentological analysis at 1:50 and 1:200 scale presented on a digital log and a hardcopy log

Sedimentological analysis of the cores (carbonate, clastic or in alternations) will be provided at any scale. The analysis will be delivered both in high resolution digital (tiff or pdf images) and in hardcopy format. Resolution will be highly depended on the frequency of coring and plugging material and on the quality of the core itself.

G2. Interpretation of image logs (to be provided by client) and incorporation into sedimentological description

Incorporation of image logs interpretation (as it will be provided by the client) into the sedimentological description will add data, and may result in a more robust analysis. Again, it depends on resolution at the core/plugs levels.

G3. Thin section preparations at agreed selected depths, stained and unstained, with detailed petrographic description

Preparation methods for thin sections of carbonates for a petrographically study apparently differ from thin sections for paleontological-stratigraphical study, specifically considering thicknesses that allow best fossils structural architecture and matrix or “framework” determination. Dunham’s updated study as well as our experience from relevant carbonate sections worldwide will provide a good classification scheme and possible depositional environment for the presently studied material.

G4. Scanning Electron Micrographs at selected scales with description and interpretation

It enables a detailed, in very high resolution (>magnifications) study, both of the rocks and their possible content in fossils. Depending on the quality of the original samples (preservation status, alteration) and their type, SEM microphotographs at any reasonably selected scale that may be required, can be produced and interpreted, following the applicable classification system for each rock-type.

G5. Bio-stratigraphic framework analyses, with follow-up if requested

Thorough biostratigraphy, for both clastic (smear slides) and carbonate (thin sections) rocks is provided. Microphotographs documentation, detailed list of frequencies and other type of material (stratigraphic tables, reworked material comments, paleoecologic-paleoclimatologic trends, etc.) are excluded from this price.

G6. Mineralogical analysis by XRD as required, with description and interpretation (whole rock and fine fractions)

Our XRD facilities may provide very detailed data both for the bulk sample and at single point analysis.

G7. Interpretation of regional geology and sequence stratigraphy

A synthesis of all previously mentioned data will enable their interpretation, tied to the regional geological data from the literature and/or those provided by the client. Sequence stratigraphy will be feasible if additional well data and adequate seismic data are available.

G8. Rock typing

Based on the smear slides and the thin sections description, both under the polarized microscope and SEM (for the available samples that include SEM data), the rock type will be provided, following relevant internationally applicable classification systems, such as Dunham's and others.

G9. CT Scanning

Computerized Tomography Scanning (or CT-Scanning), will be available for specific samples.

G10. Core plug trimming

Trimming of both sides of a plug is among the labor's provided services. It is based on our extensive experience and depends on the rock type of the plug, alteration and tectonic fracturation that may directly affect the trimming procedure and minimize or maximize plug length, thus influencing any subsequent results expected.

G11. Compilation in digital graphic format with core images, logs and links to geological data

A Compilation Report in digital graphic format will be delivered, including the core images from various angles, various logs provided by the client and available interlinked geological data.

C1. Core unpacking and initial description

A first general, visual inspection for core description will be provided, based on main rock type, grain and/or crustal size and density, alteration, karstification presence, oxidation, rock homo- or hetero-geneity, main and minor recognized rock minerals existing, possible type of cementation, occurrence and type of macro- or microfossils, porosity/permeability distribution estimation, oil/gas presence (smell, bitumens), tectonism (joints, fractures, filling), orientation relevant to well-axis, bedding-laminae plane, other sedimentological structures, unconformities, potential depositional environment.

C2. Core preservation, handling, storage

Since cores allow not only first visual examination of depositional sequences but also first reservoir type characterization, subsampling is made possible by a plug driller (a radial core slabbing saw), operating with cooling water to enable the reduction of heat and thus the quality improvement of the rock type. Plugs may be of standard length or not depending on the rock type of the core, the original length of core, the dip, etc. Subsampling maybe taken either at fixed intervals, or at selected core locations, based on the primary visual description of the core and the overlying and underlying intervals. Depending on time of further examination in the lab, the plug may be stored in a plastic tube closed in both ends by wax, not enabling exchange with the environment, keeping safe its natural liquid content (hydrocarbons-water), covered by an extra plastic bag and stored/or not in a refrigerator at stable temperature of 4^{o}C, depending on the time of lab tests.

C3. Core cleaning

Core cleaning is performed in a Soxhlet apparatus. The sample is placed in a cellulose thimble and extracted for at least 24 hours (until the circulated solvent is clear) with 300ml of a solvent mixture of Dichloromethane and Methanol in a ratio of 9:1. After cleaning, the sample is placed for 3 hours in an oven at 60^{o}C to evaporate any remaining solvent. If needed, the core samples are cleaned through selected solvents under presssure using a Hassler type core holder.

C4. Porosity and grain density

Effective Porosity and grain density of the core samples will be measured with Boyle's Law porosimeter with Helium as the working fluid. Operational He pressure is up to 10 bar. The measured drop of pressure is function to the void volume in the sample cell and it is estimated through calibration vs known volume standards. The grain volume of the core sample is then calculated. External volume of the samples will be measured based on their external dimensions or using Hg porosimetry. 3D Optical scan is available for irregularly shaped samples.

C5. Absolute Gas Permeability

The absolute permeability of a rock is the permeability of the rock to a nonreacting fluid when it is fully saturated with that fluid. It is calculated using the Darcy's equation, which indicates a direct relationship between the velocity and the pressure gradient during the flow.

Absolute air permeability will be measured using a Hassler type apparatus. The method requires pre-cleaned and dried samples. Klinkenberg permeability may also be calculated, if required.

C6. Liquids' saturation

The oil and water content represent the fraction of the effective porosity occupied by the specific fluid in a core sample. They are measured by Dean-Stark methodology. According to the procedure oil is removed from the sample by extraction, i.e. dissolved in a suitable solvent, most commonly toluene, xylene, naphtha or solvent mixtures of selected composition. The mixture of core's water and solvents' vapors is evaporated by distillation and further condensed in a suitable volumetric tube, where water is separated gravimetrically and quantitatively determined.

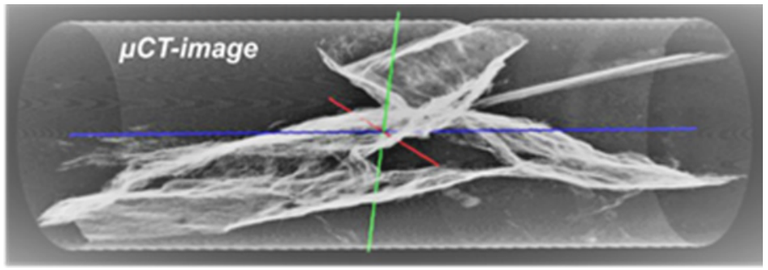
C7. Spectral Gamma Ray

Most common Spectral Gamma (γ-) natural radioactivity uses Potassium (40K), Uranium (238U) and Thorium (232Th) isotopes. Gamma radiation in oil industry is usually recorded in API units (alternatively in MeV). A detector is used coupled by a PC system with relevant software for the data record and analysis. Sodium iodide (NaI) crystals are the most widely used scintillation material for (γ-ray) Gamma-ray spectroscopy. Usually the laboratory measurements of core samples from a well compared to those from the field well-logging in situ, show a) better resolution in specific stratigraphic intervals and b) point to shifts in depth of the oil formations upper and lower limits, thus enabling us defining in a better, more accurate way the oil column and subsequently allowing to draw better conclusions on the sensitive financial results (by refining the volumetrics).

C8. Statigraphic and geological description

Stratigraphy will be based on hetereogeneity, bedding, matrix, rounding of grains, bio-skeletons and other material and type(s), development of sedimentary structures, presence of argillaceous layers or laminae, presence of oxidation surfaces, graduality, various types of unconformities, and relevant Information on the neighbor well for formation architectural development. Correlation with analogues is crucial for a better geological understanding of main formations and sedimentary facies in the sedimentary basin.

Fracture Analysis (Whole-Core)



High resolution micro-CT image from a carbonate core plug, showing the detailed geometry of the microfractures and their overlapping setting (image from Kokkalas et al., 2020 EAGE, 4th Naturally Fractured Reservoir Conference).

F1. Digital Graphic format links, data preparation for fracture models, optimum well orientation consultancy

1) Set up in digital graphic format with logs and core images will be included in the report along with appendix for all data that might be needed for fracture model building;

2) Consultancy on the overall fracture habitat and optimum well directions can be done along with all the rest available data (structural data, borehole data, in-situ stress, outcrop data, fracture orientations, stratigraphic, geochemical, etc.).

The cost will be analogous to the work needed, depending on the amount of relevant data which will be synthesized, in order to provide best estimates for future well directions.

F2. Digital Core phorography

Standard, stable, high resolution digital photography of the core at specific distance from the core, depending on the length and bedding/axis angle of the later. Various light types and angles can be used for highlighting important points or layers, such as fossils and/or sedimentary structures, voids, grain size changing, etc. 3D imaging is possible after request.

F3. Core orientation

Based on proper data availability the cores or sidewall core plugs will be oriented and marked properly in order to proceed further for the digital imaging (micro CT, SEM or thin section imaging on selected intervals). Description of the selected core intervals will include color scheme, compositional and textural classification of carbonates based on the megascopic and microscopic classification schemes and fracture description (geometry, aperture variation, orientation to match fractures observed in core and on available image logs for a cross-reference of interpreted image logs).

F4. Fracture (including micro-frack) description

Fracture description (aperture, roughness, open/closed, fracture density P_{21}, P_{32}) will be done by the combination of core macroscopic description, microCT images, thin section imaging (jPOR software) and SEM micrographs in order to capture several scales of observation. The fracture azimuths, apertures, and dips are measured using the projection lines (sine curves) on the circumferential CT images. Fracture porosity, permeability and transmissibility will be estimated both from image analysis and simulation, as well from the analytical measurements in the lab (poro-perm measurements).

Special Core Analysis

SC1. Relative Permeability – steady state of water - oil and gas - oil

The concept of effective permeability may be applied to simultaneous flow of more than one fluid of the rock, assuming that each phase has an effective permeability, which is a function of its percentage saturation.

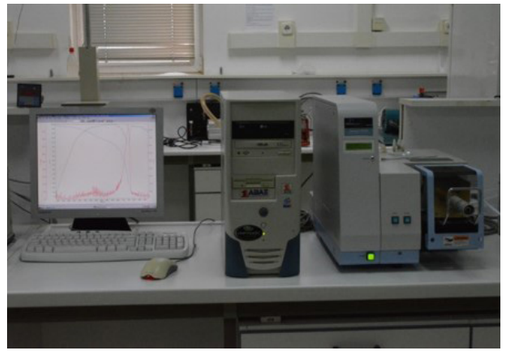
Relative permeabilities of oil-water phases are measured in a special Hassler-type apparatus, enabling the simultaneous flow of both phases throughout the core. The injection enables the mixing of the phases at different ratios. Measurement of the two flows is carried out in the outlet of the system. High pressure pumps and mass flow controllers are used for flow control and measurement.

SC2. Mercury injection capillary pressure

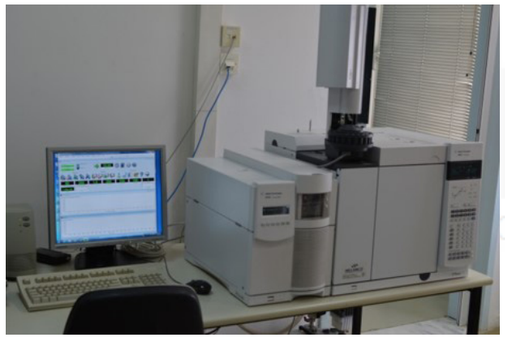
Mercury injection capillary pressure method is used to determine pore size distribution in porous substances (e.g. core samples). It is carried out using the UOP 578-84 methodology. A Hg Temco pycnometer (PN-1.5-5) with a high pressure Hg pump (Ruska 1451) is used.

Organic Geochemistry

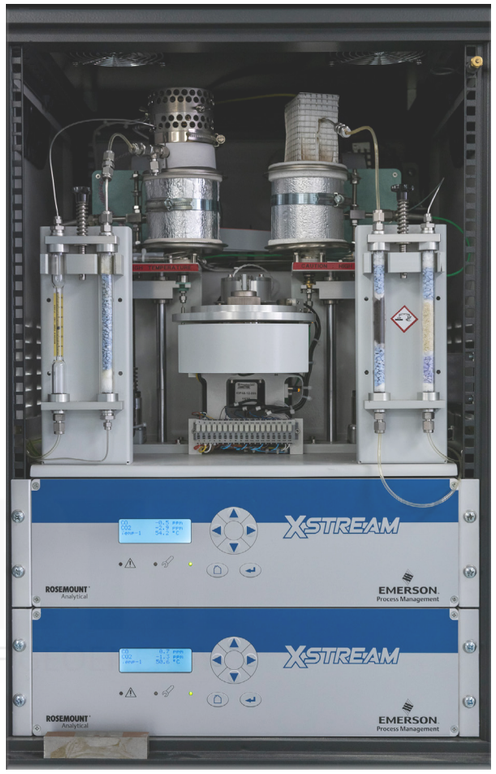
EQUIPEMENT AND CAPABILITIES



DTA



GC-MS

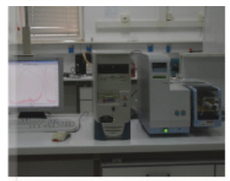


Rock-Eval

HPLC

Pyrolysis - GC

GC-MS thermal desorption unit



Thermal Gravimetry Diff. Thermal Analysis

HP 5890 GC

OG1. Sample lithology description

A lithological description will be provided for each sample, according to the standard procedures (color, pores, interconnecting-system, sediment structures, fossils, fractures, main components, cement, matrix), including all important parameters for a detailed description and screening for the geochemical analysis to follow. Any major differences from the original main-core description will be documented and in detail presented and evaluated.

OG2. Programmed pyrolysis (Tmax, S1, S2…)

Rock-Eval pyrolysis using RE VI turbo system. Determination of Tmax, S1, S2, S3, Hydrogen Index (HI), Oxygen Index (OI), Production Index, TOC and mineral carbon content (Lafargue et al., 1998). Graphical representation of the results on appropriate geochemical nomograms.

Programmed pyrolysis (Tmax, S1, S2…) is performed in a Rock-Eval 6 analyser of Vinci Technologies.

Rockeval 6 is calibrated with “IFP 160000” calibration standard of Vinci Technologies and can provide the following parameters:

- S1: free hydrocarbons in sample (mg HC /g Rock)
- S2: generated hydrocarbons from thermal cracking (mg HC /g Rock)
- S3: CO_2 produced during pyrolysis (mg CO_2 /g Rock)
- Tmax: temperature at maximum of S2 peak

OG3. Total Organic Carbon determination (TOC)

TOC is measured in a Rock-Eval 6 analyser of Vinci Technologies.

Rockeval 6 is calibrated with “IFP 160000” calibration standard of Vinci Technologies.

Alternatively TOC determination is conducted using LECOanalyser. Requires sample pre-treatment to remove carbonates. It is accomplished by treating a pre-weighted amount of sample with concentrated HCl (10% vol.) at 80^{o}C, followed by distilled water washing to remove water soluble salts (chlorides) and remaining HCl.

OG4. Carbonate carbon content

The sample is crushed in a mortar or in a mill and sieved in a 60mesh (250μm) sieve. After that it is placed for 12 hours in an oven at 60^{o} C.

0.5g of dried sample is treated with 70ml of hydrochloric acid 2N. The mixture remains in an oil bath at 70^{o}C for 24 hours. Then it is centrifuged and the HCl is removed. Afterwards the sample is washed with distilled water until reaching neutral Ph and filtered through a pre-weighted ash-less filter paper. The filter paper with the sample is dried in an oven at 130^{o}C overnight and reweighed.

OG5. Elemental Analysis (CHSNO)

The analysis is carried out using a Flash-2000 CHNS-O analyzer from Thermal Scientific.

OG6. Kerogen isolation and maceral analysis

Kerogen preparation (i.e isolation from the mineral matrix) is conducted using acid treatment (HCl, HF) prior to visual analysis, aiming to remove mineral phases and to ensure good polishing quality. The resulting from acid treatment kerogen sample is embedded in an epoxy resin to make briquettes, ground flat and polished (ISO 7404-2, 2009). These samples are examined using a LEICA DMRX microscope. Maceral identification is performed in oil immersion under both white incident light and blue-light excitation (ISO 7404-3, 2009; ASTM D7708, 2014) and characterized based on the following scheme:

- FA - Fluorescing amorphous material, i.e material with undefined structures, fluorescing in UV light,
- HA - Amorphous material, i.e material with undefined fluorescing structures,
- AL - Algae of dinoflagellates,
- HE – Sporomorphs,
- WO Woody material, precursors to vitrinite,
- CO Coal and non-transluctant material
- Spore Coloration Index (SCI) is determined under transmitted light.

OG7. Solvent extraction of samples

The sample is crushed in a mortar or in a mill and sieved in a 60mesh (250μm) sieve. After that it is placed for 12 hours in an oven at 60^{o}C.

The extraction of the samples is performed in a Soxhlet apparatus. 20-40g of the sample are weighed in a glass microfibre (GF/A) thimble and extracted for at least 24 hours (until the circulated solvent is clear) with 300ml of a solvent mixture of Dichloromethane and Methanol in a ratio of 9:1. Copper strip pre-treated with concentrated hydrochloric acid is placed in the solvent flask for the removal of free sulfur of the sample. The extract is condensed to 10ml in a rotary evaporator, filtered through a glass microfibre (GF/A) filter paper and collected in a pre-weighed glass vial. It follows solvent evaporation to dryness in nitrogen stream and determination of bitumen mass.

OG8. Cold DCM analysis

Core samples are washed with cold (room temperature) dichloromethane (DCM) when light components are expected in the core extract. The procedure is carried-out using a Hassler-type holder and the DCM is forced through the core under pressure. Extract components are concentrated by gently removing DCM under a nitrogen stream.

OG9. Quantitative extract fractionation

Bitumen (soxhlet extract of a source rock) can be fractionated in four fractions: saturated hydrocarbons, aromatic hydrocarbons, resins (NSO) and asphaltenes with a two steps procedure:

- Asphaltenes precipitation
- Column Chromatography

OG10. Asphaltenes Precipitation (n-Pentane Insolubles)

An oil or a bitumen (soxhlet extract of source rock) can be fractionated in two fractions: maltenes and asphaltenes. The asphaltene fraction is removed by precipitation in a light hydrocarbon solvent (n-Pentane) followed by filtration. n-Pentane is added to the sample in a volume ratio of 10:1. The mixture is mixed in a vortex mixer in low speed and then is filtrated through a 0.45 micron filter cartridge. n-Pentane and maltenes are collected in a pre-weighed vial and evaporated to dryness in Nitrogen stream. Asphaltenes are removed from the filter by rinsing with chloroform and collected in a pre-weighted vial. Chloroform is evaporated to dryness in Nitrogen stream.

OG11. Column Chromatography

The maltene (deasphaltened) fraction of an oil or a bitumen (soxhlet extract of source rock) can be fractionated in three fractions: saturated hydrocarbons, aromatic hydrocarbons and resins (NSO), using column chromatography in an alumina silica column with elution solvents of increasing polarity . The sample is diluted in n-pentane and loaded onto the column. Saturated hydrocarbons fraction is eluted with n-pentane, aromatic hydrocarbon fraction with toluene and resins (NSO) fraction with a mixture of toluene and methanol (60/40 vol.). The elution solvents are evaporated to dryness in nitrogen stream and the sample's fractions are determined gravimetrically.

OG12. Oil analysis by gas chromatography

The analysis is carried out in an Agilent 7890 GC with a Flame Ionization detector. (GC-FID). Suitable capillary columns (length, stationary phase) are used, according to the scope of the analysis. Individual light hydrocarbons are determined based on retention times and Kovats response indices.

The composition of the whole oil is presented in terms of pseudo-compound groups based on n-alkanes. For heavy oil/extract samples an internal standard is used to estimate the un-eluted fraction.

In case of detailed analysis of the gasoline fraction the conditions of the analysis are adjusted to provide the required resolution of the peaks. Naphtha and gasoline standards are used for compound determination. Similarlly, a-alkanes and isoprenoids are detected using retention times and Kovats indices.

OG13. Alkanes and aromatics gas chromatography

The analysis provides the quantitative characteristics (concentration, peak areas or heights) of the n-alkanes and characteristic aromatic compounds of the fractions in the saturated and aromatic fraction of oils respectively. Internal standard is used for quantitation. The analysis is performed in an Agilent 7890 GC, with a Flame ionization detector. It requires oil or extract concentration and fractionation.

OG14. Alkanes and aromatics gas chromatography--mass spectrometry (GC-MS biomarkers)

The analysis aims to obtain quantitative characteristics (concentration, peak areas or heights) of the common biomarkers. An internal standard is used for quantitation.

The analysis is performed in an Agilent 7890/7650 GC/MS system with a capillary column in both Selective Ion Monitoring (SIM) and Full scan modes. It requires oil or extract concentration and fractionation.

OG15. Hydrocarbon gas analysis (C1-C5, C6+) and non-hydrocarbon gas analysis (CO2, N2, H2S)

The gas samples are analyzed using a gas chromatographic system HP-5890 with Flame Ionization (FID) and Thermal Conductivity (TCD detectors) on a Hayes Sep D column. The concentration of the gas components is calculated based on the peak areas calibrated against external standards of the pure substances. Hydrocarbon gases are measured from the FID signal, and non-hydrocarbons from the TCD one.

OG16. Stable carbon isotope ratios in C1, C2, C3, C4

The carbon isotopes in C1-C4 hydrocarbon gases are measured using a Trace 1310 GC, equipped with a Poraplot Q column, connected to a Delta V isotope ratio mass spectrometer (Thermo Fisher Scientific). The decomposition of the components, prior to isotopic analysis is carried out at 1420^{o}C.

OG17. Oil API gravity

Density of an oil sample, at 15.5^{o}C (60^{o}F), is measured with Anton Paar DMA38 pychnometer. The instrument is calibrated using air and degased distilled water.

OG18. Oil sulfur content

Sulphur content of the oil samples will be measured using an AMETEK Spectro-Xepos apparatus, following the ASTM D4294 method.

OG19. Viscosity

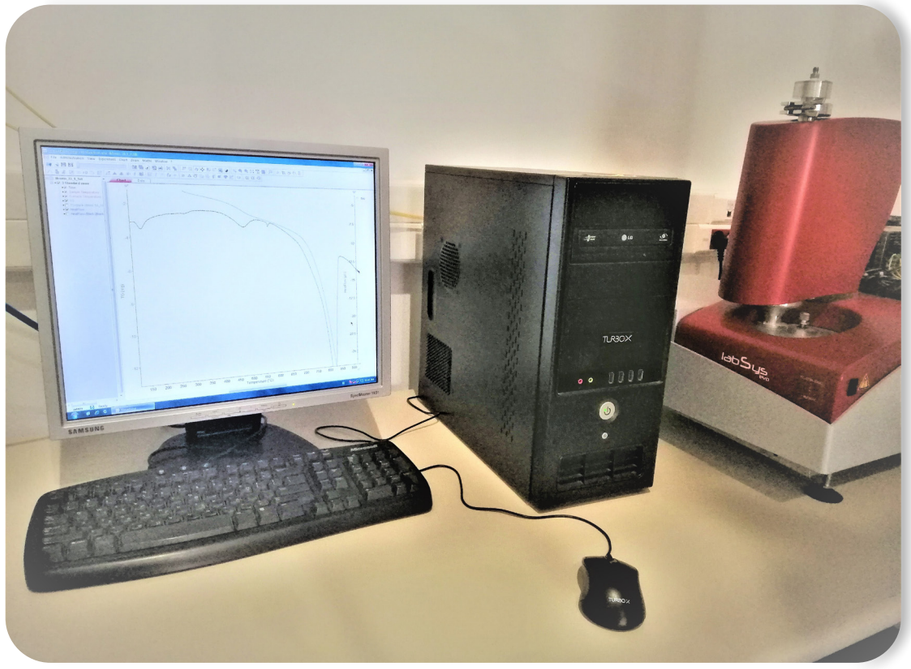
Kinematic viscosity of oil samples is measured following the ASTM D445 method.

OG20. Oil pour point / wax content

Oil pour point is determined following the standard method ASTM D97.

Wax content of an oil is determined using the SETARAM LABSYS evo Differential Scanning Calorimetry (DSC system). The measurement is based on the amount of heat, released during phase transition on the melting point of heavy paraffins of the sample.

Kinetics of Source Rock Formations



Even though the processes and mechanisms of oil generation are exceedingly complex, there is general agreement that overall reaction rates are in agreement with the Arrhenius equation.

Hydrocarbon generation process is dependent on its kinetic parameters, thermal maturity, and geochemical properties. We determine the kinetics of main formation source beds, and numerically establish a correlation between the kinetic parameters, thermal maturity indices, and the vitrinite reflectance.

Kinetic analysis is conducted using both the thermogravimetric analysis (LABSYS evo TGA) and the modelling software KINETICS 2015.

Training Courses

FORTH
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FORTH/IG offers a range of training courses in G&G oil and gas upstream, petroleum geochemistry and basin petroleum systems modelling, as well as field-based courses and training for G&G software.

In response to the growing need for online and remote learning, we are currently designing a variety of online training courses from beginner to advanced levels.

These new online courses are based on the success of our well-established and successful conventional (classroom) courses. The modules are constantly updated, modified and presented specifically for *e*-learning.

Our training options include:

- Petroleum Geology, Geochemistry and Petroleum Systems Modelling courses.
- Petroleum Software training.
- Petroleum Geology & Petroleum Systems Field Trips & Field courses held in Crete or in Western Greece Thrust & Fold Belt including taught components if required.
- We are able and willing to work with both individuals and small company groups to train and support their own projects.

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Currently, all in-person courses, whether at FORTH/IG's or at client's offices, are organized upon prevailing Covid restrictions.

Main Research Staff

Dr. Nikos Pasadakis

Director, Institute of GeoEnergy, Foundation for Research and Technology-Hellas (FORTH/IG).
Professor, School of Mineral Resources Engineering, Technical University of Crete. Director of the Postgraduate MSc program “Petroleum Engineering”.

He holds a Diploma in Chemical Engineering, on Chemical Technology of petroleum and natural gas and a PhD in Physical Chemistry, from the Department of Organic Chemical Technology of the Technical University of Lvov, former USSR.

Prof. Pasadakis’ research work focuses on (1) instrumental analysis and characterization of conventional and unconventional fuels, (2) chemometrics, data analysis and modelling of composition and properties of fossil fuels, and (3) petroleum geochemistry, applications in exploration, production and the environmental impact of fossil fuels exploitation.

He has published one book “Petroleum Geochemistry”, 60 papers in peer-reviewed international and 70 papers in refereed conferences and he has coordinated multiple research projects in oil and gas exploration and production.

Dr. Bellas, Spyridon (or Spyros), M.

Principal Researcher
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Member of the Scientific Council of the Institute of GeoEnergy

He studied Geology at Patras University, Greece and holds his Ph.D. from the Freie Universtität Berlin, Germany, studying bio-stratigraphy of deep-water foreland basin clastics and developing world-wide correlations (Eocene to Miocene age). DAAD and ERASMUS Scholar in Germany. Spyros has many publications in peer reviewed journals, and has given numerous talks while promoting the energy independency of the country (i.e. AAPG, ICE, EAGE, GSG, NAPE).

Between 2016 and 2020, he held the position of Vice President (Upstream), Executive BoD, in the State Company Hellenic Hydrocarbons Resources Management S.A. (HHRM SA). Since 2011 he became a key player and team leader of the hydrocarbons Working Group (Ministry of Environment & Energy, Upstream: Hydrocarbons Directorate). He had been Member & Negotiator in various Evaluation Committees for Awarding Blocks for E&P Licensing (On- and Offshore), in Technical Advisory Cmtes., Member of, the Prinos Production Field Cmte., the South Kavala Underground Gas Storage Project Cmte., the Maritime Licensing Cmte. (MFA) and the Environmental Preservation Cmte. of Limin Keri (Zakynthos oil seeps & leakages), while he has initiated many SEIAs, in the framework required for future sustainable Exploration. He acts as the Oil & Gas Expert representative of Greece in the European Federation of Geologists (EFG).

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He’s a French senior petroleum geoscientist over 20 years of experience based on multidisciplinary geoscience techniques such as geochemistry, geology, geophysic, basin modelling and petroleum systems analysis in order to define exploration opportunities, new play concept and new guidelines for an exploration policy. Since 1999 he has been involved in different integrated studies (Pakistan, Argentina, Algeria, Tunisia, Russia, New-Zealand, India, Papua New Guinea, Indonesia, Oman, Malaysia, Vietnam, Thailand and Saudi Arabia) for major national oil and gas companies, Petroleum Institutes and major petroleum operators in various international oil and gas exploration & production projects in structurally complex areas. He’s specialized to develop, test, implement, and define exploration opportunities, new play concept and new guidelines in term of risk and resource assessment..

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Vayanna Makri is a Research Assistant at the Institute of GeoEnergy (IG) since 2021. She holds a BSc degree in Geology and GeoEnvironment from the National and Kapodistrian University of Athens and two MSc degrees; one in Petroleum Engineering from the Technical University of Crete and one in Integrated Petroleum Geoscience from the University of Aberdeen.

Her research focuses on basin and petroleum system analysis, more specifically on basin modelling, geochemical applications in source rock and oil characterization, kinetic analysis, chemometrics and sedimentology. Yet, her interests cover also static-dynamic reservoir modelling, relative but not exclusively tied to subsurface gas storage, while she aims to achieve a multi-disciplinary approach in her research combining interrelated fields such as geology, geochemistry, geophysics, petrophysics and paleoclimatology. .She has presented papers at international conferences (EAGE, RawMat).

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