



INSTITUTO  
MEXICANO  
DEL  
PETRÓLEO

# Exploration and Production Services

## Directory

Exploration and Production Services  
Direction  
Jorge Alfonso Mendoza Amuchástegui  
Ph. (52) 55 9175-6230  
jamendoz@imp.mx

Exploration Solutions Office  
Julio César González Lara  
Ph. (52) 55 9175-8316  
jcgonzal@imp.mx

Exploitation Solutions Office  
Héctor Hernández García  
Ph. (52) 55 9175-7070  
hhgarcia@imp.mx

Surface & Subsurface Facility Solutions Office  
Saúl Bautista Fragoso  
Ph. (52) 55 9175-82 97  
sfragoso@imp.mx

Well Tools & Systems Solutions Office  
Armando Méndez Castro  
Ph. (52) 782 826-4725  
amendez@imp.mx

Exploration & Production Services Office,  
Offshore Region  
Lenín Ulín Jiménez  
Ph. (52) 938 381-2001  
lulin@imp.mx

Exploration & Production Services Office,  
Northern Region  
Víctor Manuel Casasola Varela  
Ph. (52)782 826-4709  
casasola@imp.mx

Exploration & Production Services Office,  
Southern Region  
Mario Alberto Hernández Puente  
Ph. (52) 993 310-8301  
mhernand@imp.mx

Commercial Strategies Office  
José Chávez García  
(52) 55 9175-7993  
jchavezg@imp.mx



INSTITUTO MEXICANO DEL PETRÓLEO

# Exploration and Production Services

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## Direction of Exploration and Production Services

The principal functions of the Direction are to develop and execute the portfolio of technological projects; to approve technical and financial proposals; to participate in the portfolio of technological research and development projects, and to promote and market technological services and integral solutions.

The Direction is comprised of four solutions offices or areas:

- Exploration
- Exploitation
- Surface and Sub-Surface Facilities
- Well Tools and Systems

All these offices analyze the demand for services and products; arrange transferring and assimilation programming with the research Directions; ensure all projects are of high quality, timely, and technological content; coordinate and prepare the technical and financial proposals for the products and services, and execute the projects and gather the team with the skills needed.

In addition, there are three Service offices:

- Exploration & Production, Northern Region
- Exploration & Production, Southern Region
- Exploration & Production, Offshore Region

All these offices promote integral solutions and specific services; manage and formalize annual and multi-year contracts; liaise with Pemex managers and assistant managers in the region, and operate the post-sale projects in the region.

Specifically, the Direction of Exploration & Production Services stays with the client, both upstream and downstream, to attend to their requirements associated with the assessment of oil-producing potential, incorporation of reserves, deposit engineering, field development, increase recovery factor, and subsurface and surface production systems and facilities.

**Contact:**

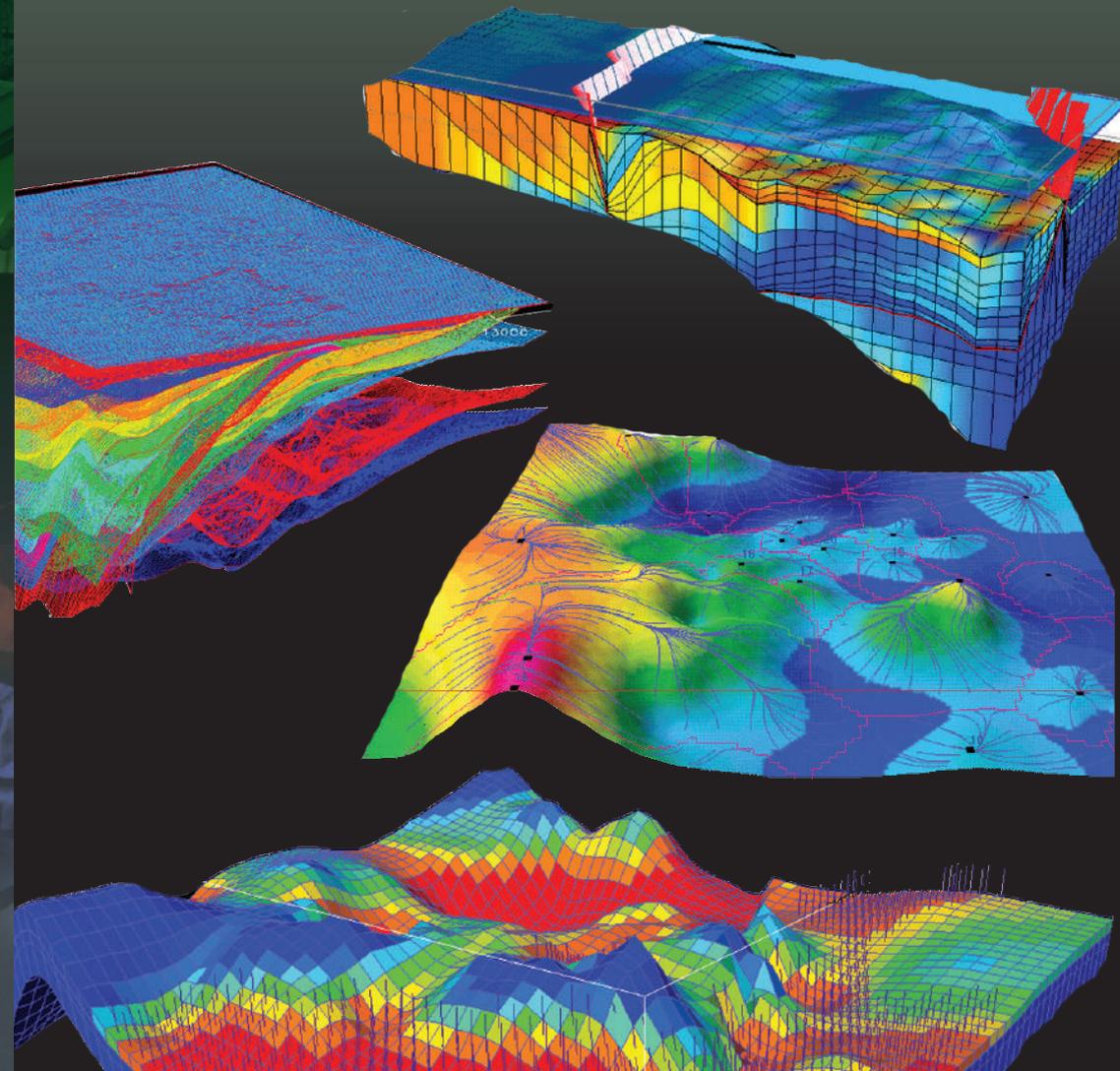
Jorge Alfonso Mendoza Amuchástegui  
Director of Exploration & Production Services  
Ph. (52) 55 9175-6230  
jamendoz@imp.mx

## Products, Services and Solutions for Hydrocarbon Exploration

- Sedimentary basins
- Petroleum systems
- Plays assessment
- Prospects

**Contact:**

Exploration Solutions Office  
Julio César González Lara  
Ph. (52) 55 9175-8316  
jcgonzal@imp.mx



### Biostratigraphy

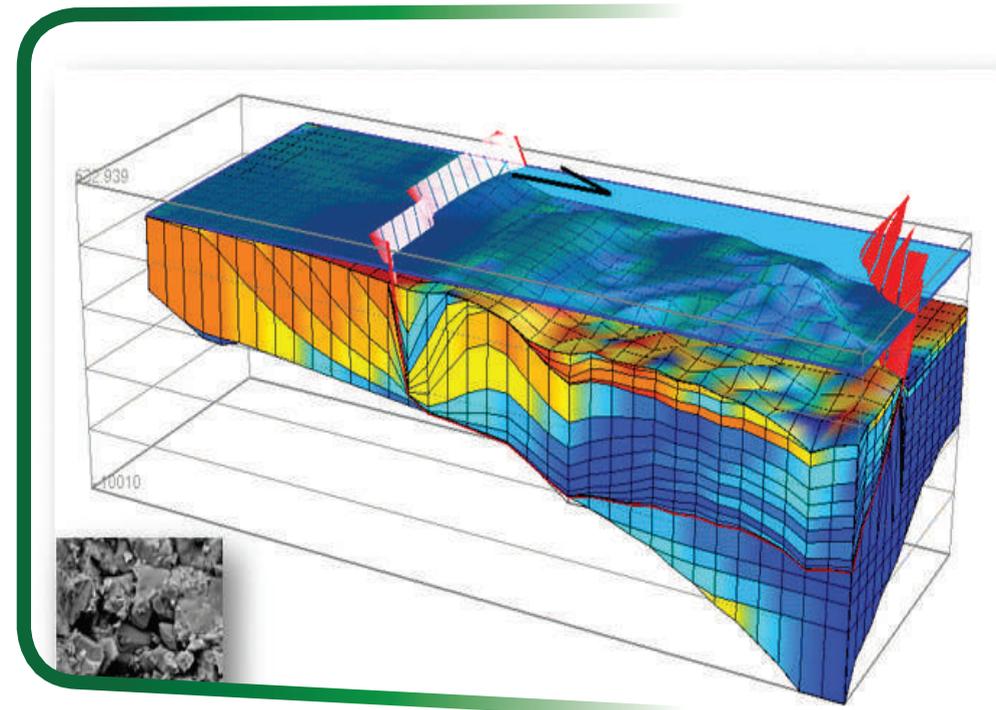
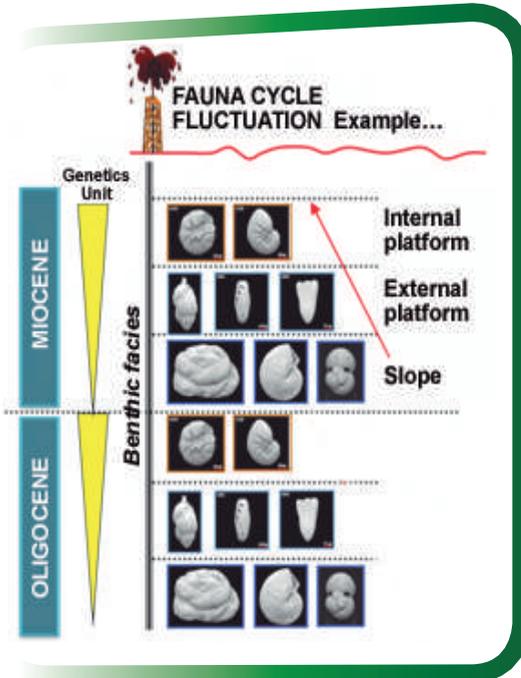
The constantly changing knowledge of the fossil record and its genetic implications for sedimentary processes has led to a better understanding and use of species in establishing chronostratigraphic frameworks for oil interests.

Biostratigraphy has evolved to such extent that it has become an important pattern for understanding and identifying geological events and modeling, and petroleum systems.

Biostratigraphic studies in the oil industry, when applied to their maximum potential, support decision-making to define new areas of strategic interest, adapting to the requirements of the business.

#### Studies

- Dating (rocks, seismic reflectors, bio-events, stratigraphic surfaces, hiatus, etc.)
- Correlated base timelines
- Establishment of biozones and chronostratigraphic calibration
- Definition and interpretation of bio-events with seismic lines
- Establishment of paleoecological and paleobathymetric models
- Determination of biofacies and interpretation of deposit environment
- Detection and measuring of stratigraphic discontinuities (paraconformities) not observable with other tools
- Sequential analysis (condensed sections, discontinuities, maximum flooding surfaces, ranges of sedimentation, reworked fossils, sequence limits, deposit system limits, etc.)



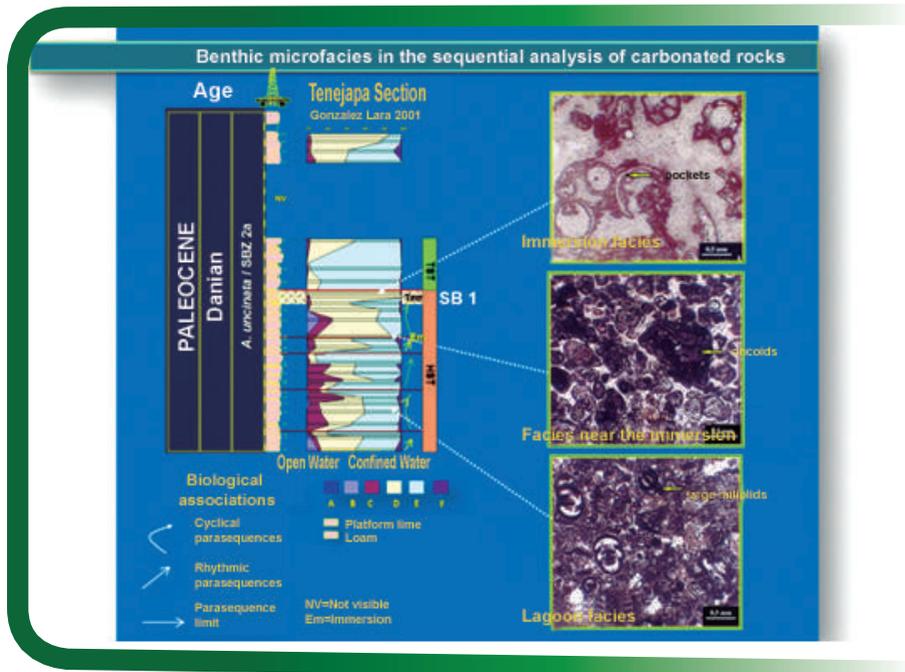
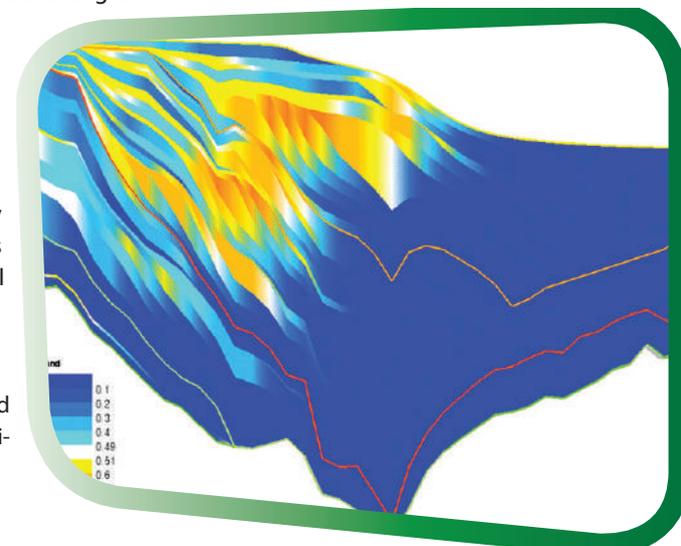
### Sedimentology and Diagenesis

Sedimentology studies are the characterization of facies in clastic and carbonated sedimentary systems, the definition of sedimentary body geometries, and the development of the architecture and dynamics of facies over time and space. Diagenetic studies complement the characterization by defining the post-sedimentary geological processes and the mineral changes in the sedimentary sequences. They also determine the petrophysical properties of rocks in terms of fracturing, porosity and permeability to define the quality as reservoir the facies have with economic oil interests.

- Characterization, classification and description of sedimentary facies and diagenetic facies
- Development of sedimentary and dynamic models, based on time and space
- Chronology of sedimentary and diagenetic events
- Correlation sections and maps of facies and petrophysical properties
- Evaluation of the quality of storage rocks

#### Studies

- Characterization and description of sedimentary systems



**Geochemistry**

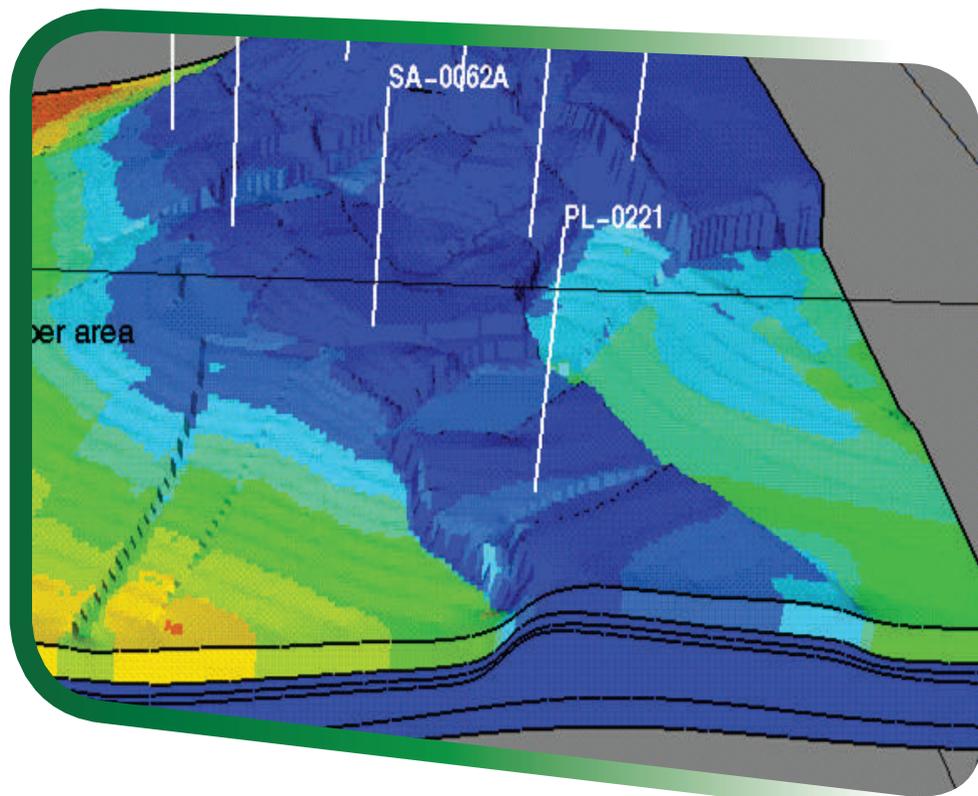
**Exploration Geochemistry**

Hydrocarbon source rocks and the petroleum systems in the basins are characterized and defined. It is identifying the different derivative compounds and establishing the relationships over time and space between origin and hydrocarbon products and volumetrics, at each stage.

determining the relationships over time and space between origin and hydrocarbon products and volumetrics at each stage.

Results are expressed in terms of:

- 1 Type of organic matter, production and/or storage potential, and degree of maturity
- 2 Composition of oils and crude, origin, deposit environment, age, and degree of thermal maturity
- 3 Producer source rock-crude oil and oil-



**Reservoir and Production Geochemistry**

The characterization of oil reservoirs fluids, establishing their relationships of origin and determining the internal structure in terms of partitioning, connectivity and analysis of heterogeneities in the oil column.

- 4 Degree of maturity
- 5 Generating mass-expulsion-migration-accumulation balance

**Environmental Geochemistry**

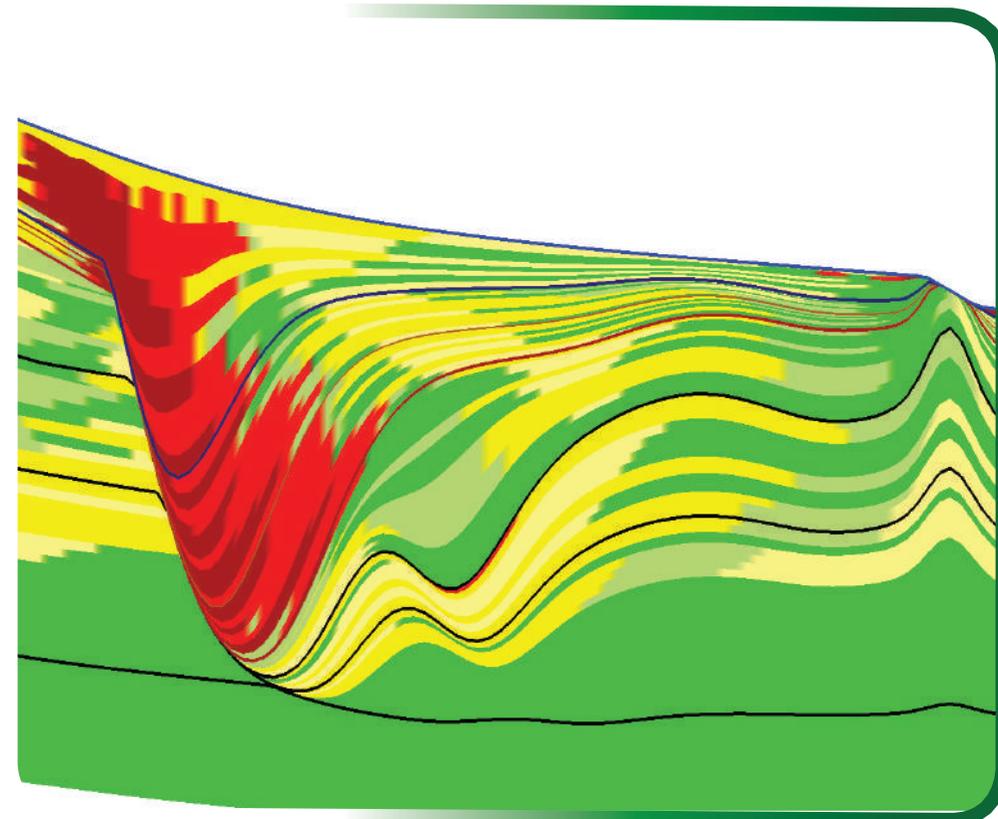
The identification of pollutant compounds in soils, sub-soils, waters and the environment, determining the origin and quantity of pollutants and remediation strategies.

**Reservoir Geochemistry**

- Characterization of hydrocarbon compounds in oil reservoirs and determination of the hydrocarbon column in terms of behavior, connectivity and heterogeneities
- The results also include applications for the oil-oil and oil-rock correlation, and monitoring the water-oil contact in individual oil fields.

**Exploration Geochemistry**

The characterization of hydrocarbon source rocks and the molecular identification of the different derivative fluids and compounds,



**Geological Modelling**

Numerical models are constructed from geological, geochemical, and geophysical data, characterizing and simulating the geopetroleum processes using a dynamic space-time perspective in 1D, 2D, 3D, and 4D. Services may be grouped into the following: simulation of sedimentary processes and stratigraphic models, experimental analog models, balancing and restoration of structural sections, structural kinematic models and simulation, hydrocarbon producer kinetic models.

texture of sedimentary units at the basin, sub-basin or sedimentary environment scale, based on geological, geophysical and geochemical information.

**Structural Modelling**

Either 2D or 3D, the 3D analysis of the permeability of fault systems and comprehensive structural modelling; describes two and three dimensional models that are in turn comprised of numerical models representing the two and three dimensional structural-geological context, restored and geometrically balanced, of a specific area.

The geological models developed are applied in the assessment of oil potential on different scales, from the regional level of evaluation of sedimentary basins, through the semi-detailed level in the appraisal of petroleum systems, to the level of detail in the characterization and definition of plays and oil prospects.

**Experimental Analog Modelling**

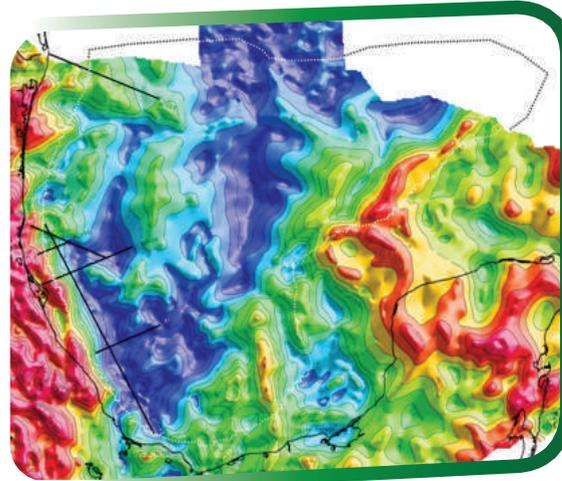
Experimental analog models are designed and developed to lab simulate the different types of structures that occur during a sedimentary sequence deformation process to then study the parameters that control their geometry and evolution.

**Studies**  
**Sedimentological and Stratigraphic Modelling**  
Considers the simulation of the formation, evolution and stratigraphic archi-

**Compositional Kinetic Models**  
Analysis protocols are designed to obtain compositional kinetic parameters for hydrocarbon production.

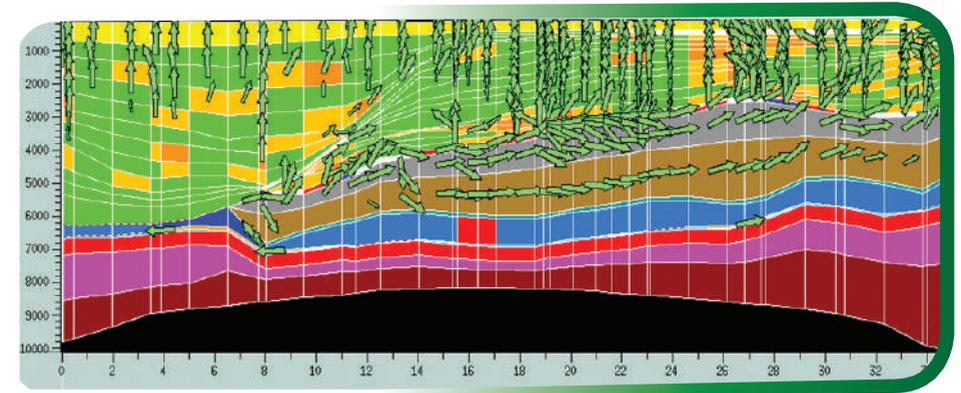
### Basin Analysis

The overall focus of basin analysis studies allow helping to analyze, interpret, and compile geographic, geological, geophysical and geochemical information to evaluate sedimentary basins with economic oil interests. The regional geotectonic framework is established, from the base dynamic and the lithospheric mechanisms to the basin formation processes; the stages of sedimentary and sequential stratigraphic evolution are defined and the associated tectonic mechanisms, and the history of the subsidence and thermal conductivity is determined for economic and oil appraisal, and to define the exploration strategy.



#### Studies

- Geometry of the basin and geotectonic position
- Architecture, organization and nature of the base
- Architecture and organization of sedimentary sequences
- Sedimentary stages and their relationship in the tectonic context
- Chronostratigraphic framework
- Tectonic phases and deformation styles
- Time-space evolution
- Appraisal of the oil potential

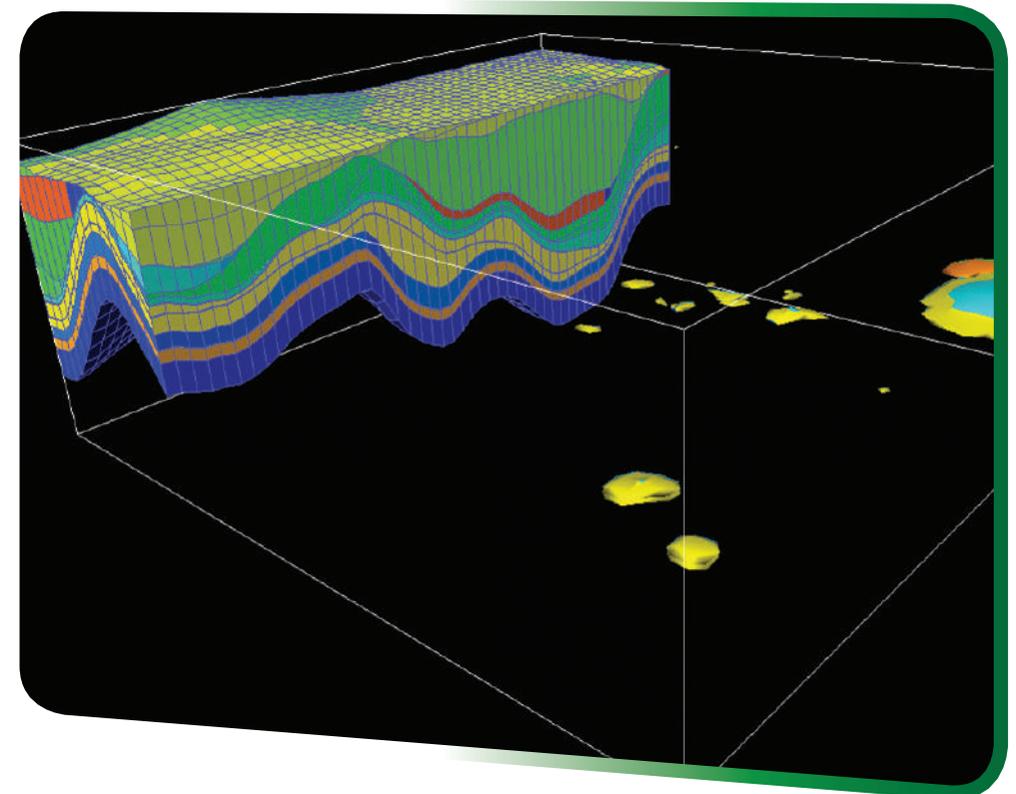
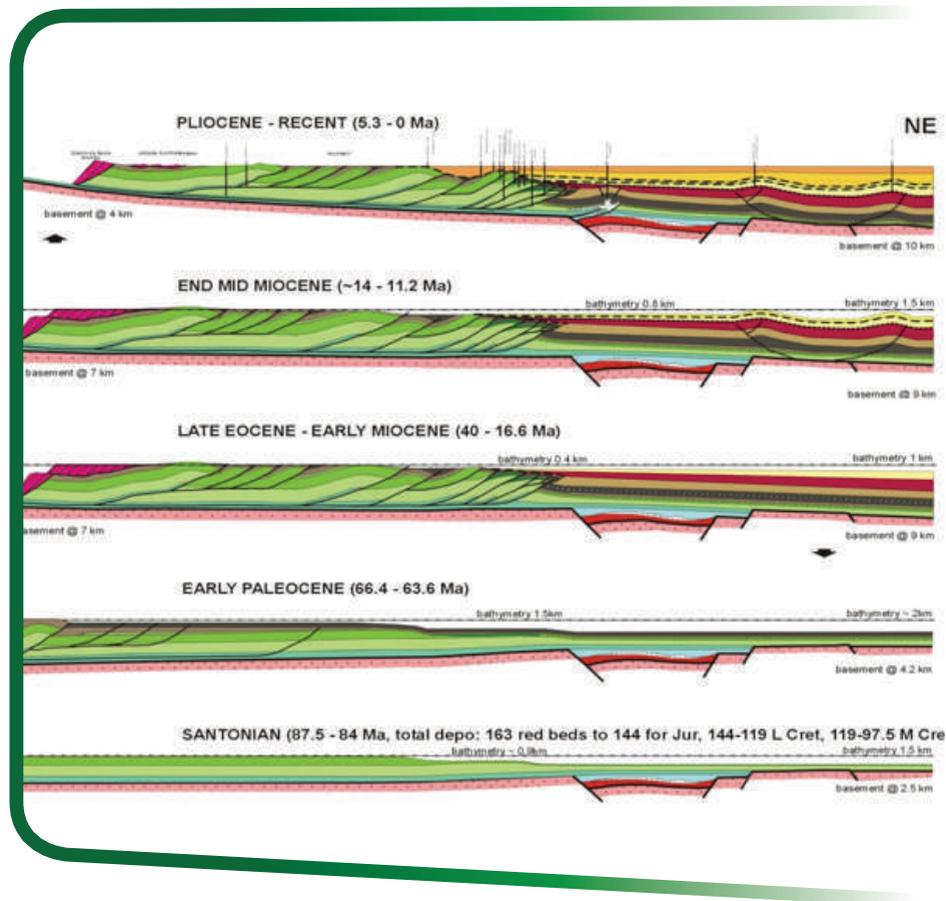


### Evaluation of Petroleum Systems

The IMP offers solutions to aid in oil exploration decision-making, characterizing and determining in 4D the evolution of the elements (source, reservoirs and seals rocks) and the processes (formation of traps, hydrocarbon generation-expulsion-migration) of the petroleum systems in prospective sedimentary basins, through the validation, interpretation, compiling, simulation, and modeling of geological, geochemical, and geophysical data.

#### Evaluation:

- Simulation and modelling of hydrocarbon producing subsystems, quantification of productivity
- Structural analysis and modelling of storage systems, estimate of hydrocarbon storage and retention capacities
- Simulation and modelling of hydrocarbon generation-expulsion-migration processes in 4D
- Evaluation of potential oil resources
- Exploration strategies
- Definition of petroleum systems using digital and/or geographic information



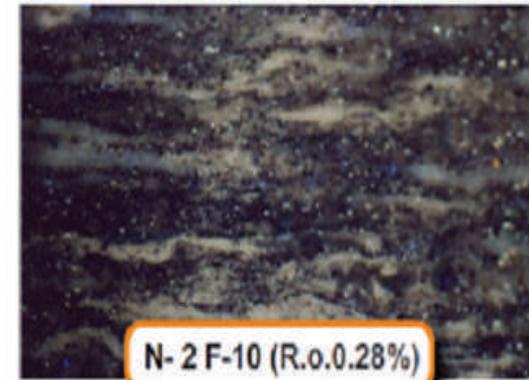
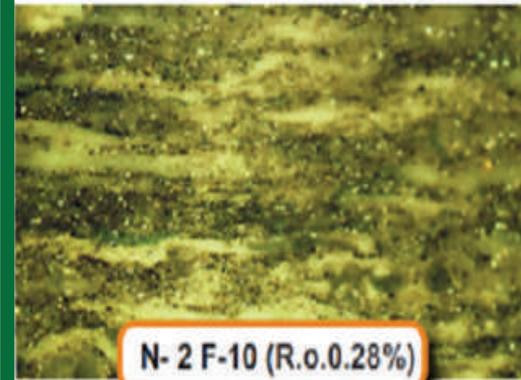
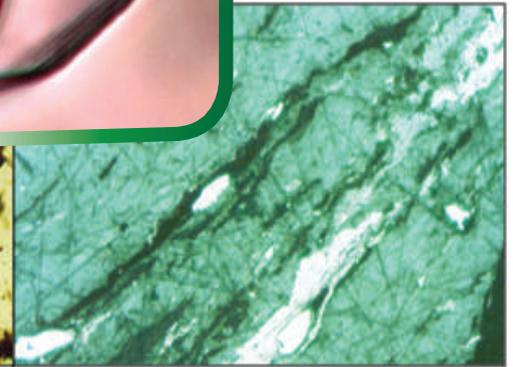
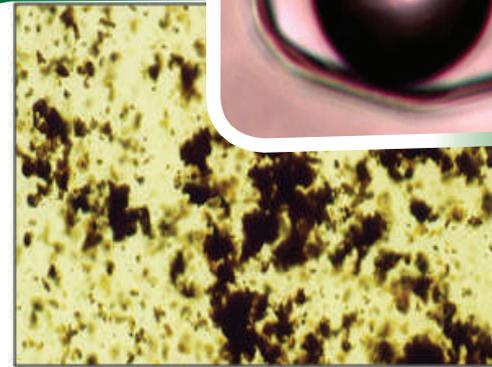
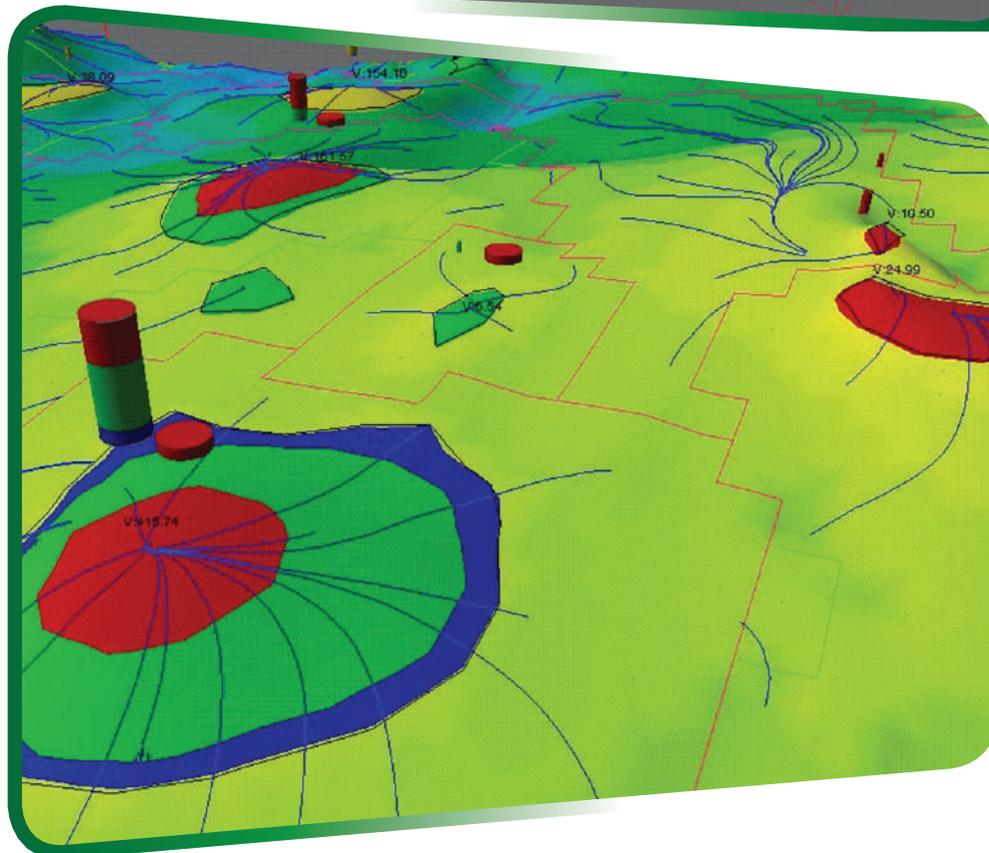
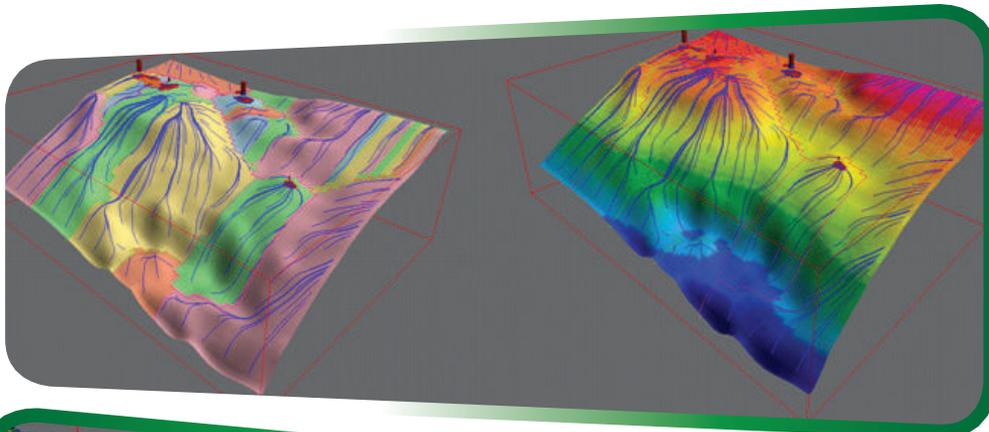
### Play Assessment

Geological, geochemical, and geophysical information is gathered to conduct the economic oil assessment and analysis of plays and oil prospects that are genetically related in generation, accumulation, formation of traps, migration, and preservation of hydrocarbons.

Play assessment studies provide an inventory of plays-prospects that guide decision-making in terms of investments in exploration and the incorporation of new and/or remnant reserves.

### Evaluation

- Analysis and evaluation of petroleum system elements
- Hydrocarbon production-migration-accumulation
- Timing of geopetroleum processes
- Evaluation and quantification of the geological risk
- Definition and analysis of plays
- Delimitation of plays
- Calculation of hydrocarbon volumes
- Sensitivity analysis
- Plays-prospect portfolio



### Organic Petrography

Studies and analyses are offered for parameters and physical and optical properties of organic fossil material and hydrocarbons contained in sedimentary rocks, to characterize and determine the quality of hydrocarbon source and reservoir rocks, and evaluate the oil potential.

#### Studies

- Type, quality, abundance, and maturity of the organic material under transmitted light and fluorescent light
- Reflectance of lignocellulosic materials under reflected white light
- Reflectance of bitumen under reflected white light

- Fluorescence of hydrogenated materials under ultraviolet fluorescent light
- Fluorescence of hydrocarbons under ultraviolet light
- Determination of API grades in oils
- Fluorescence of 360 to 690 nm hydrocarbons
- Migrabitumen content, bacteria, sulfur, chemical pollutants and mineral matrix in liquid hydrocarbons
- Optical characterization using 3D laser confocal microscopy for fluids and oil residues, kerogen, hydrocarbon mixes, drilling fluids, stimulants, and flow enhancers, water and salinity in oils, inlaying in drilling pipe bubbles

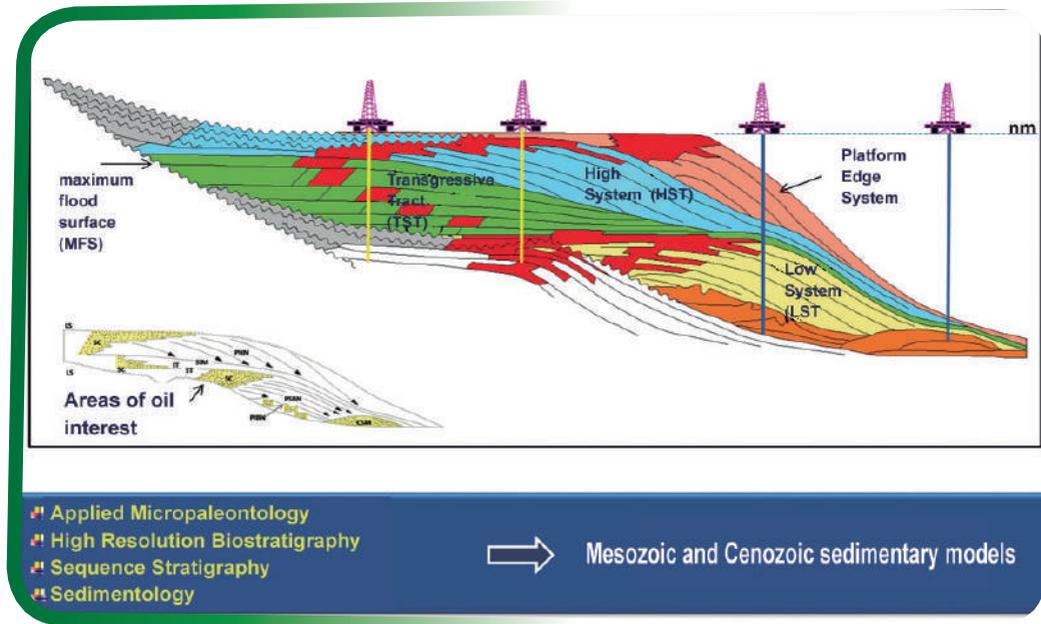
### Technological Improvements for Exploration Process

The design, construction, integration, implementation and support of specialized programs, methodologies, or transfer of new technologies for application in technological solutions for the processing, interpretation, synthesis and management of hydrocarbon exploration information and data.

The design, development, and implementation of information systems and local applications in the different exploration disciplines, through client-server service to enter, consult, edit, update, integrate, and table and graphic visualization of information, with levels of confidentiality.

### Technological developments

- Definition, analysis, classification and standardization of information and data
- Analysis, design and development of specialized databases
- Design and development of information systems for decision-making
- Assimilation, adaptation, testing and implementation of commercial and non-commercial software
- Design and development user interfaces
- Validation and entering of information into specialized systems
- Design and development of tools for the usage of the information and application of analysis processes
- Analysis, design and development of web applications
- Upgrading and maintenance of systems and methodologies



### Technical Assistance in Geosciences

Scientific and technological support for clients in the different Exploration disciplines in which the IMP has experts and experience, such as Cenozoic Biostratigraphy, Mesozoic Biostratigraphy, Sedimentology and Diagenesis, Structural Geology and Tectonics, Petroleum Systems, Basin Analysis, Geochemistry, and Geostatistics.

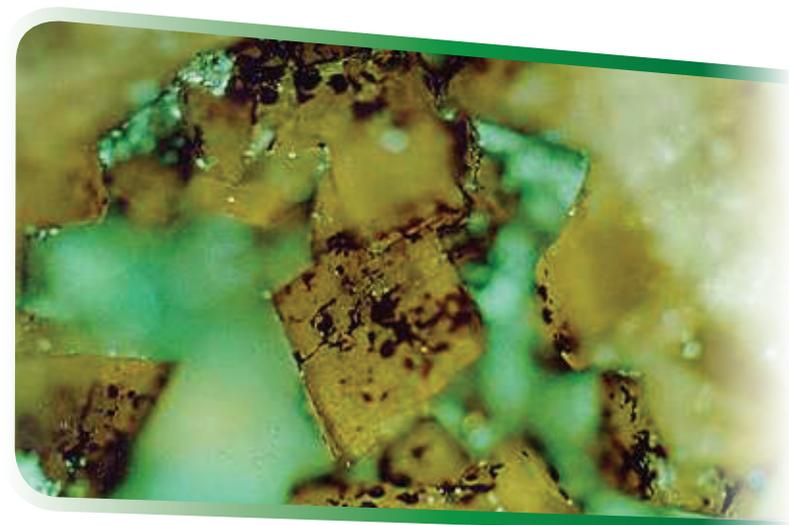
#### Exploration Geosciences:

- Experts and specialists in the various geoscience disciplines: stratigraphy, sedimentology, geochemistry, structural geology, geostatistics
- Experts and specialists in taxonomy and systematics for the principal Mesozoic and Cenozoic fossil groups

- Experts and specialists in biostratigraphy, sedimentary basins, and petroleum systems in Mexico

#### Relevant experience in:

- Consulting and specialist training in Basin Analysis
- Consulting and specialist training in Biostratigraphy and graphic correlation
- Consulting and specialist training in Structural Geology and Tectonics
- Consulting and specialist training in Geochemistry
- Consulting and training in Information Systems for decision-making



### Subsurface Imaging in Depth

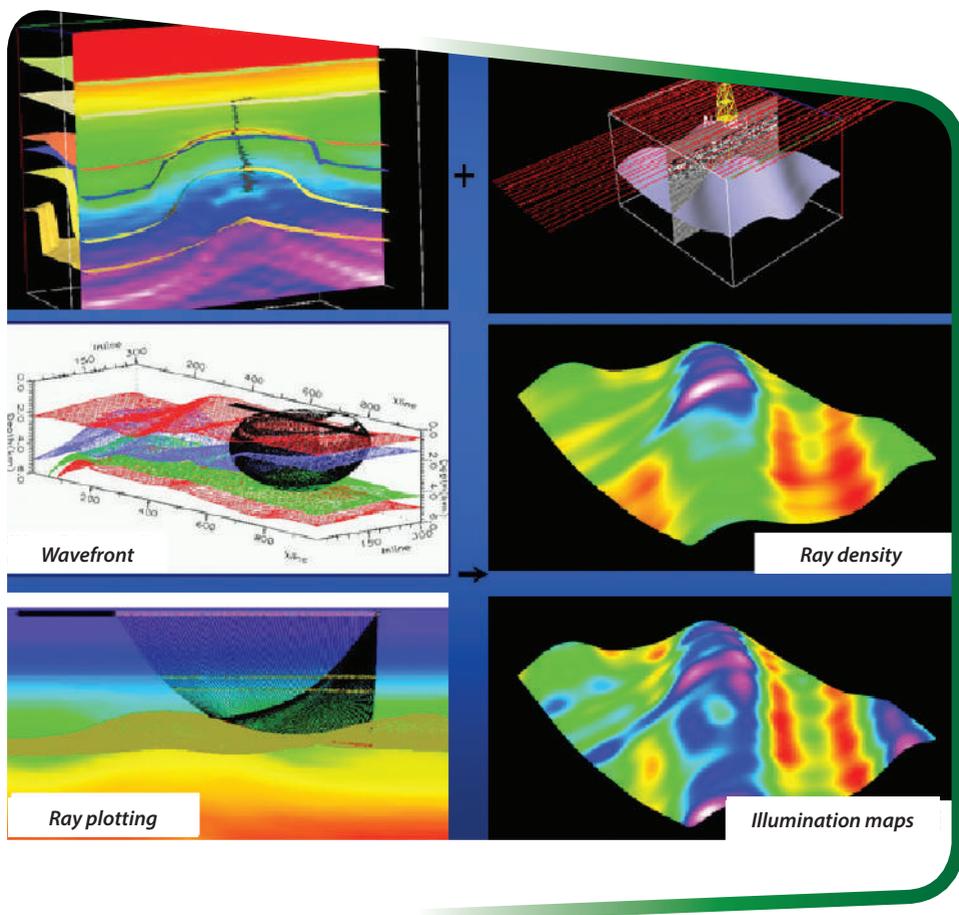
The subsurface imaging in depth service includes two components: depth migration before stacking and seismic modelling studies.

#### Depth Migration

Consists of the construction of interval velocity models and the application of seismic representation algorithms (migration), useful for the interpretation of geophysical and geological subsurface characteristics, particularly in zones of complex structural geology, such as intense development fault systems, salt tectonics areas, etc.

#### Seismic Modelling

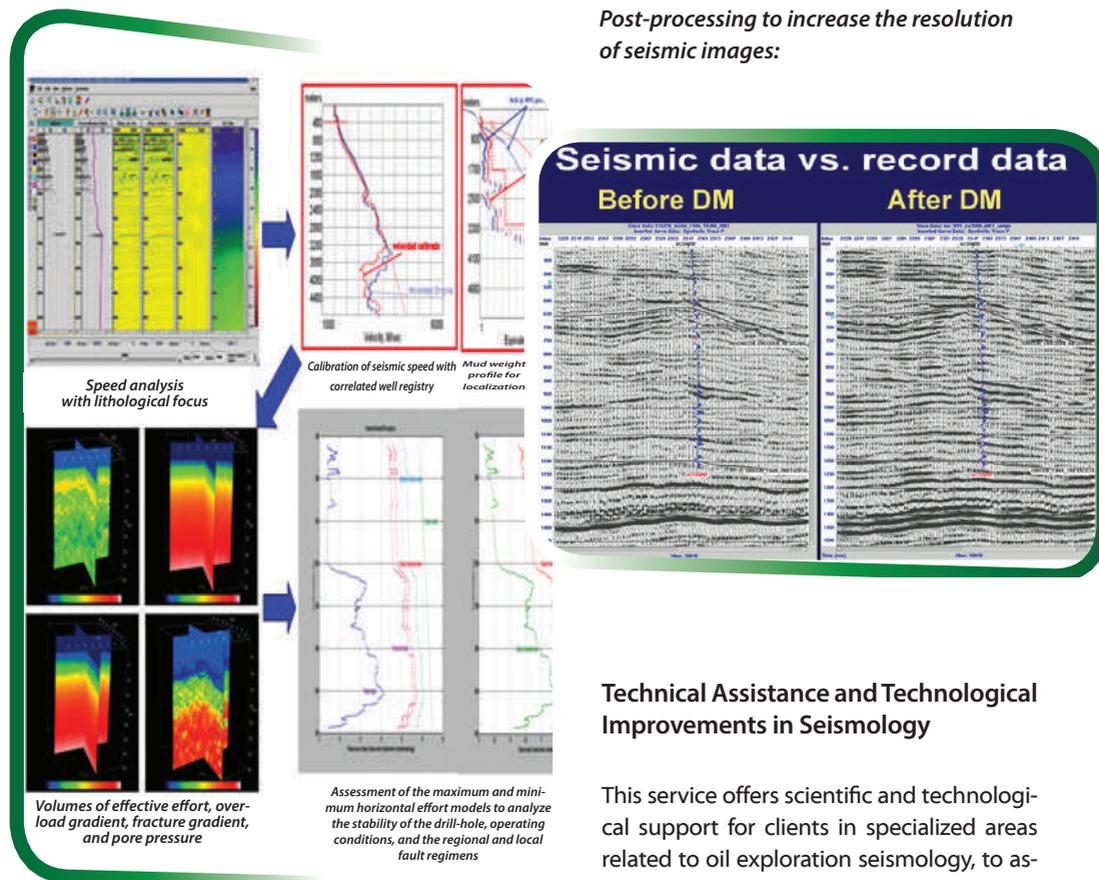
These studies are based on the numerical simulation of rays or wave propagation plotting, to support the acquisition design of seismic data, illumination analysis, proof of models derived from seismic interpretations, validation and adjustment of velocity models.



### Pore Pressure Prediction

Three dimensional predictions are prepared before drilling a well location in deep Gulf of Mexico, including: pore pressure, fracture gradient, overload gradient and effective stress, to determine and assess the occurrence risks of possible zones with abnormal pressure in the well trajectory.

- Reduction of the risk and uncertainty of exploratory sites in the deep Gulf of Mexico, where each drilled well costs more than US\$150 million, having higher resolution models for pore pressure prediction
- High integration level for state-of-the-art technologies and methodologies
- Strong impact in terms of achieving PEMEX's strategic goals for the incorporation of reserves and increased hydrocarbon production from the deep Gulf of Mexico basins



### Technical Assistance and Technological Improvements in Seismology

This service offers scientific and technological support for clients in specialized areas related to oil exploration seismology, to assess and implement international state-of-the-art technology, updates its personnel, and designs integrated methodologies to resolve specific problems related to the use of seismology, to infer geophysical, geological, lithological, petrophysical, and fluid characteristics in the subsurface.

Topics of technological interest and PEP solution needs:

Increase in frequency:

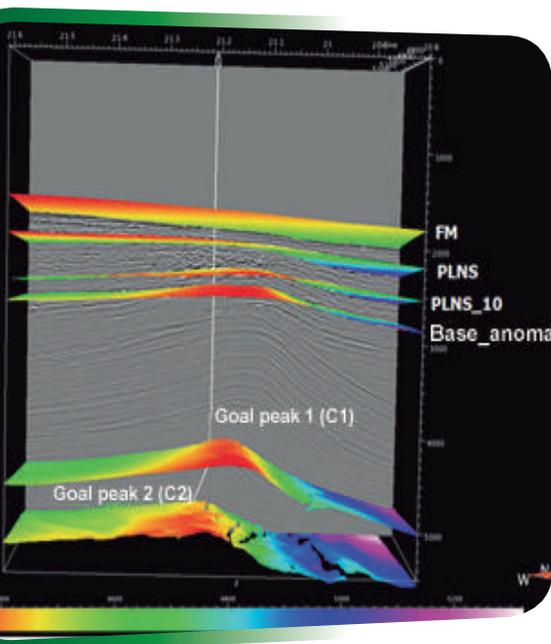
- Vertical and lateral resolution of reflectors
- Improvements in the detection of reflection patterns:
- Geometric attributes (morphology and lateral variability)
- Multi-component seismology:
- Multi-component data processing
- Rock physics:
- Establishes the relationship between geophysical measures and rock properties
- Depth migration, anisotropy and seismic lapse:
- Fundamentals, implications and new methods
- Unconventional Deposits:
- Shale Gas-Oil Example

#### Methodology

The construction of lithological velocity models with geological consistency in tertiary and Mesozoic sediments using the geostatistics method and block model (differentiation schematic with traditional methods); using calibrated seismic velocities, interpreted horizons, well records (P & S sonic), and geological models.

Calculation methods to construct pressure profiles and their spatial solution by generating geopressure volumes in 3D, based on the lithological velocity model, and petrophysical, geological, and drilling data.

Development of the Geomechanical Model (drill-hole stability). Geomechanics of wells comprised of an operating window, which includes PP, PF, OBG, ShG, SHG, and SFG (collapse). Resistance properties, UCS, FANG, and E & V elastic modules considering lithologies and petrophysical studies. Propagation cube of seismic velocities. Determination of control fluid density and optimization of the well trajectory.



**Shallow Geo Hazards**

The purpose of Shallow Risk Studies is to generate a qualitative assessment of the risk levels (gas pockets, hydrates, faults close to the surface, flows of shallow waters, non-consolidated sediments, anomalies in the ocean floor), using geological, geophysical, and production data.

Risk reduction in drilling of exploratory sites in the deep Gulf of Mexico (water depths greater than 500 m), mitigating the physical, environmental, and financial impact of a drilling accident caused by certain geological characteristics.

**“Lakach-1001” Shallow Risk Study**

Shallow risk is assessed based on the characteristics of the ocean floor and structural and stratigraphic conditions of the shallow geological column (to 800 m.b.n.m) of the proposed drilling site in the 5 x 5 km seismic cube location, so that the location sits in the center and the physical, environmental, and financial impact that could occur during drilling can be assessed and/or prevented.

**The results sought include:**

- Analysis of the results obtained, determining the zones with shallow risk using the attribute maps generated, and also the Inline and Xline analyses of the location to

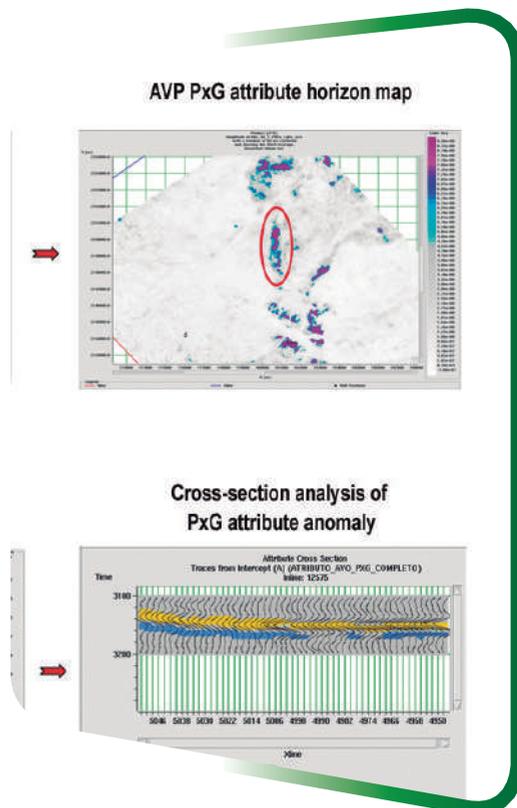
reduce uncertainty during the drilling of the proposed site.

- Transformation of time at depth for each of the horizons, determining the depths, geometries and thicknesses of the principal risks.
- Analysis of the seismic characteristics of the ocean floor and the stratigraphic column to determine possible risk zones, using seismic attributes, in 5 x 5 km area.
- Generate a risk table, with a time and depth ratio for all risk anomalies for drilling.

**AVO, Inversion and Seismic Attributes**

AVO studies (amplitude anomalies analysis), inversion and multiple seismic attributes produce useful images for interpreting geophysical, geological, lithological and subsurface fluid characteristics, including amplitude analysis versus source-recipient distance, acoustic and elastic inversion, and multiple seismic attributes.

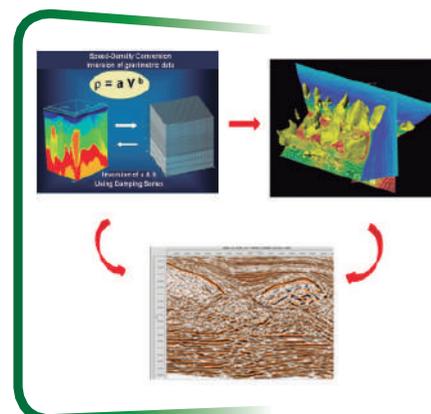
This type of study helps to infer behavioral patterns of seismic reflection amplitude, associated with geological formations with possibilities of containing hydrocarbons.



**Conventional Seismic Data Processing**

Consists of generating seismic images in the domain of time reflection, in two and three dimensions, through the application of digital signal management algorithms and wave propagation theory to oil exploration seismology data, directly associated with the structural and stratigraphic characteristics of the subsurface.

This study supports the localization for the identification and determination of the characterization of oil deposits, through the transformation of field data from seismic reflection exploration into interpretable information.

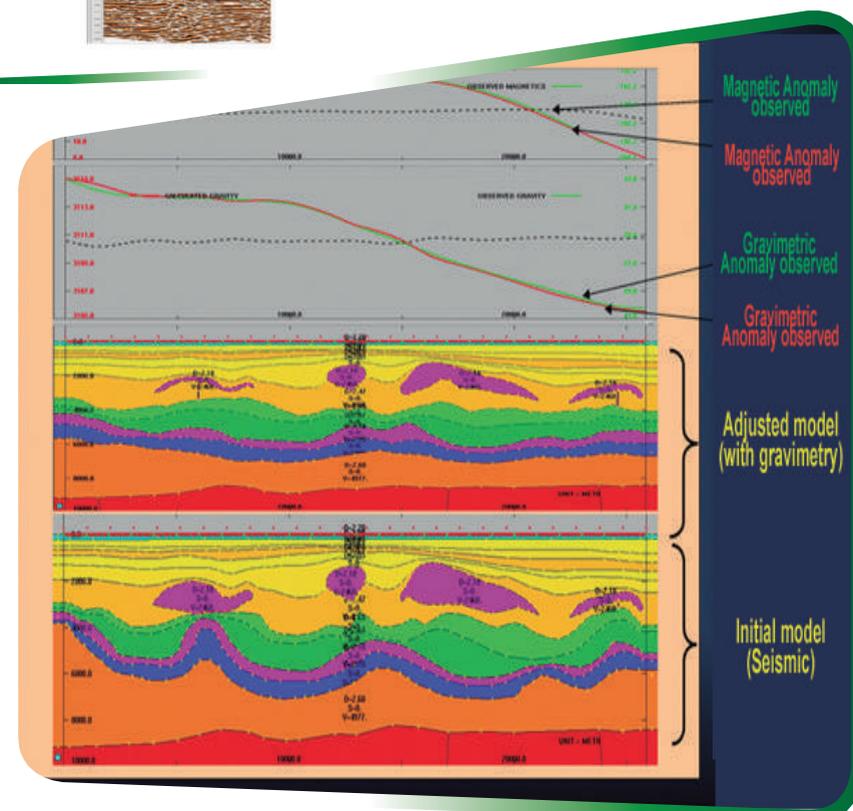


**Potential Methods**

Potential Methods generate a series of gravimetric and magnetometric models that describe in two or three dimensions, the structure and geological-petroleum characteristics from a regional level to a prospect level.

**Studies**

- Morphological estimate of the magnetic base of the basin and sedimentary horizons with oil interests
- Definition of areas for exploration
- Development of a velocity model for the application of the depth migration process of the seismic section
- Estimate of the crust-mantle interface to create tectonic models
- Definition of the base for the sub-saline structures
- Determination of the morphology of intrusive igneous bodies in the basin
- Support in the definition of structural traps



**Seismic Information Preservation**

This service involves the protection, control, and updating of digital seismic information on magnetic media and printed on film, under controlled conditions, for remote access and use of ordered information from the PEP Geophysics Direction (formerly, the National Center of Seismological Processing), assuring availability and timely supply of seismic information for the whole country.

The product consists of the gathering, protection, control, and updating of the CNPS databases, and also the timely delivery of information requested to the client. The information is stored according to international standards applying the security measures necessary, in order to protect client information.

IMP National Tape Library

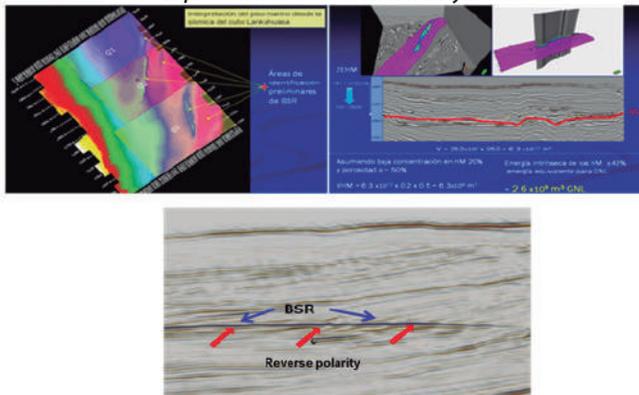


**Gas Hydrates Exploration**

This service includes the application of a workflow for the identification and initial volumetric estimate of the probable accumulations of gas hydrates. Using seismic information, anomalies known as “bottom simulating reflectors” (BSR) are determined, to estimate the spatial extension of hydrates impregnated in ocean sediments present in Mexican seas, located in water depths greater than 800 m, to assess their future commercial energy potential.

Geological-geophysical criteria are used in the seismic interpretation to identify these impregnated zones, such as the BSR determinate and strata (onlap) terminations with seismic attributes, identification of geological structures associated with hydrate formation, such as fault systems, gas conductors, bleaching areas in the hydrate stability zone, and probable associated gas concentration zones.

Exploration of Unconventional Hydrocarbons



**Products, Services and Solutions for the Exploitation of Hydrocarbons**

- Reservoir evaluation
- Hydrocarbons recovery

**Contact:**  
 Exploitation Solutions Office  
 Héctor Hernández García  
 Ph. (52) 55 9175-7070  
 hhgarcia@imp.mx



**Reservoir evaluation**

Services aimed at the definition and study of the geological, petrophysical, and dynamic characteristics that control the accumulation and production of hydrocarbon reservoirs, and the quantification of hydrocarbon volumes in such reservoirs. Included here are the development and evaluation of strategies and options for the exploitation of hydrocarbon fields, to support operating plans to optimize exploitation and increase reserves or production.

**Portfolio of services**

Nine services are offered:

- Special studies of reservoir fluids
- Special studies of rock samples
- Quantification of hydrocarbons initially in place and assessment of reserves
- Dynamic reservoir characterization
- Geological-petrophysical reservoir characterization
- Numerical reservoir simulation
- Geophysical well-log processing for naturally fractured reservoirs (NFRs) and complex lithologies
- Deepwater field development and planning

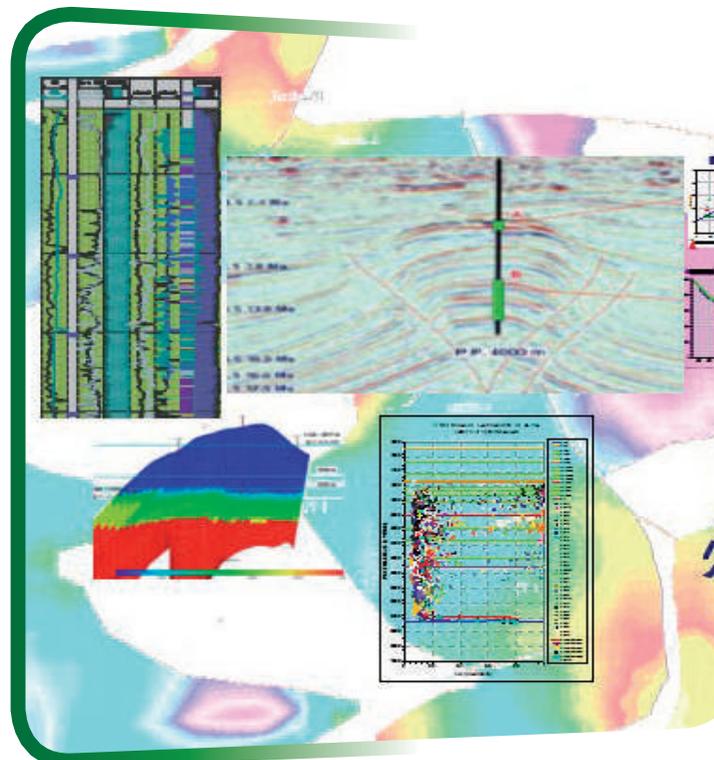
• Application of the VCD methodology for exploration and production projects  
 These services are offered individually, integrated with each other or integrated into other Exploration & Production lines of business, according to the specific customers' needs.

**Special studies of reservoir fluids**

Specialized lab services for PVT and compositional analysis of reservoir fluids, to analyze the composition and characteristics of the fluids under surface and reservoir pressure and temperature conditions, as well as their behavior in the presence of fluids used in hydrocarbon recovery processes.

**Specialized studies of rock samples**

Specialized lab services to determine petrophysical parameters such as porosity, absolute permeability, saturation of fluids, capillary pressure, both in plugs and in full diameter cores and under atmospheric or reservoir conditions. Also offered is the service of cutting and preparing thin sections obtained from cores, used in various studies for the static reservoir characterization.



**Numerical reservoir simulation**

Development of numerical models that represent the geology and petrophysics of the reservoir, and the behavior of fluids flow in porous media. In the case of development fields, the numerical model must replicate, as close as possible, the pressure-production history on a field and well basis. The service also includes the development and analysis of optimal options for the exploitation of reservoirs, from field development to the implementation of secondary and/or improved recovery models.

**Quantification of hydrocarbons initially in place and assessment of reserves**

Estimation of the original hydrocarbons in place of oil and gas reservoirs by using probabilistic and deterministic volumetric methods. Also, the determination of hydrocarbon reserves, applying methods such as volumetric approaches, material balance, decline curves, and numerical reservoir simulation.

**Geophysical well-log processing for naturally fractured reservoirs (NFRs) and complex lithologies**

Specialized studies to evaluate the distribution of petrophysical properties in different systems (matrix, fractures, and vugs) at pore level, to perform an improved static reservoir characterization; and also to determine water saturation, connectivity, and to predict permeability values through the petrophysical inversion process.

**Dynamic reservoir characterization**

Analysis and interpretation of pressure transient tests and production data to evaluate the dynamic properties that control the flow of fluids in the well-reservoir system. Elements of the static reservoir model are identified and confirmed by using dynamic reservoir characterization methods.

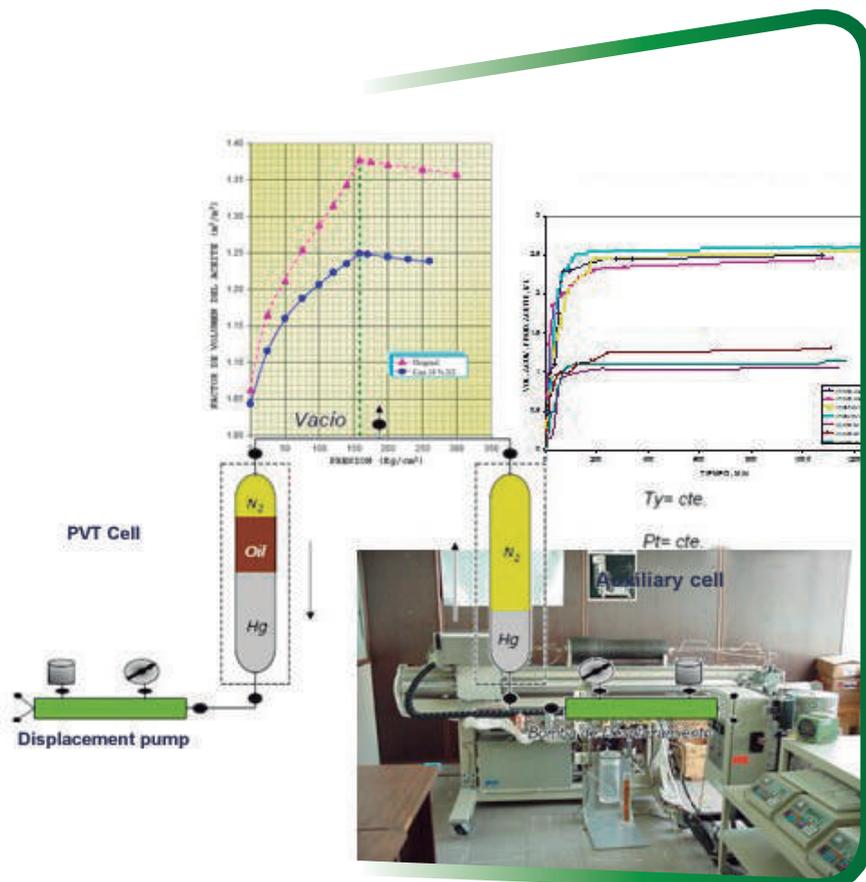
**Deepwater field development and planning**  
 This service helps to identify the possible development options for the exploitation of deepwater fields, and also the economic assessment of these scenarios using uncertainty analysis.

**Geological-petrophysical reservoir characterization**

Determination of the geological characteristics, petrophysical properties, limits and volumes of geological formations that constitute a hydrocarbon reservoir. The studies are remarkable by the integration of results from seismic, geological, and reservoir engineering studies.

**Application of the VCD methodology for exploration and production projects**

Application of the VCD methodology for hydrocarbon exploration and production projects. Determination of the scope of these projects and achievement of the business goals, by minimizing variations in production, time, and cost.



**Hydrocarbon recovery**

Study of secondary and improved hydrocarbon recovery processes in oil reservoirs, to increase the recovery factor.

**Portfolio of services**

Three services are offered:

- Tracer injection studies
- Special hydrocarbon recovery studies
- Technical assistance and technology development for reservoir engineering and hydrocarbon recovery

These services are offered individually, integrated with each other or integrated into other Exploration & Production lines of business, according to the specific customers' needs.

**Tracer injection studies**

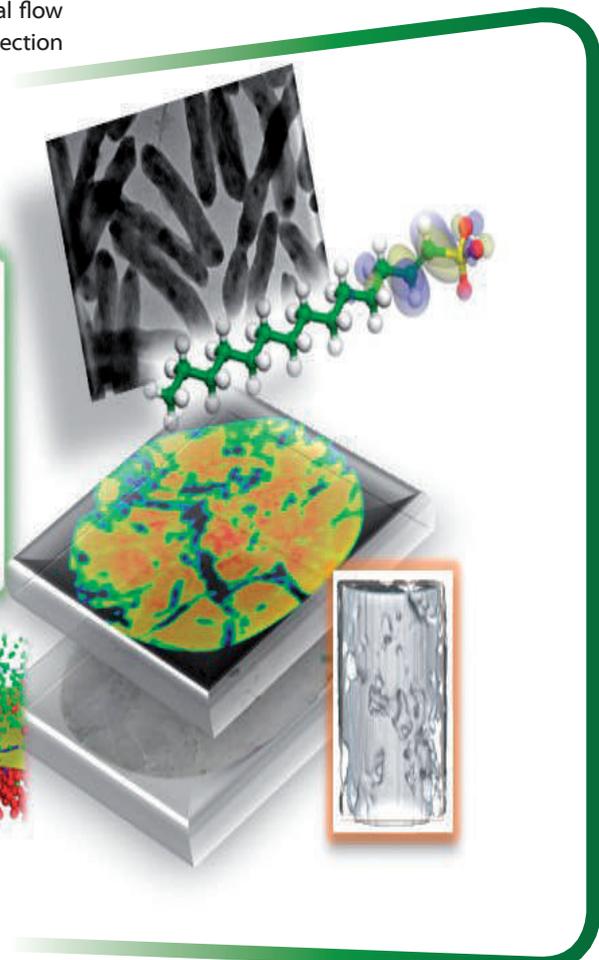
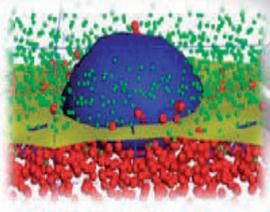
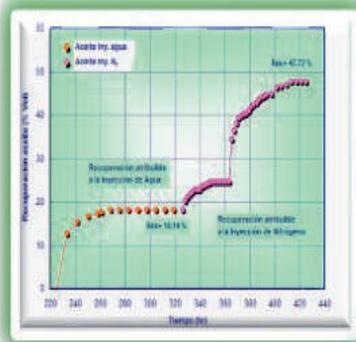
Design, operation, and interpretation of results related to the injection of tracers in reservoirs to determine the dynamic conditions of reservoirs and also for the quantitative determination of the principal flow parameters that influence fluid injection processes.

**Special hydrocarbon recovery studies**

Assessment of processes associated with gas injection ( $N_2$ ,  $CO_2$ , natural gas, and mixtures of these), chemical product injection (gels, foams, etc.), microbial recovery processes (MEOR), and thermal recovery processes (steam injection, in situ combustion). The studies developed include an assessment of parameters such as diffusion, convection, fluid transfer, matrix-fracture, and oil deposit recovery factors.

**Technical assistance and technology development for reservoir engineering and hydrocarbon recovery**

The service offers technical assistance, through specialized consulting provided by expert personnel in the different areas of reservoir engineering and hydrocarbon recovery processes, and also in the generation or assimilation of technological developments in these areas of knowledge.



**Products, Services and Solutions for Surface and Subsurface Facilities**

Studies are performed for the diagnostic, design, assessment, and optimization of well production systems, surface production facilities, the handling, treatment, transportation and measuring of fluids, and the optimization of hydrocarbon production processes in real time. Technical assistance is also provided for the planning of deep water fields, in terms of submarine systems and production facilities, and support for lab certification and well testing and facility accreditation.

**Portfolio of services**

- Evaluation, design, and optimization of surface production facilities
- Fluid measuring systems
- Flow system and artificial production system studies
- Real time optimization of production processes
- Submarine systems and production facilities for deep waters

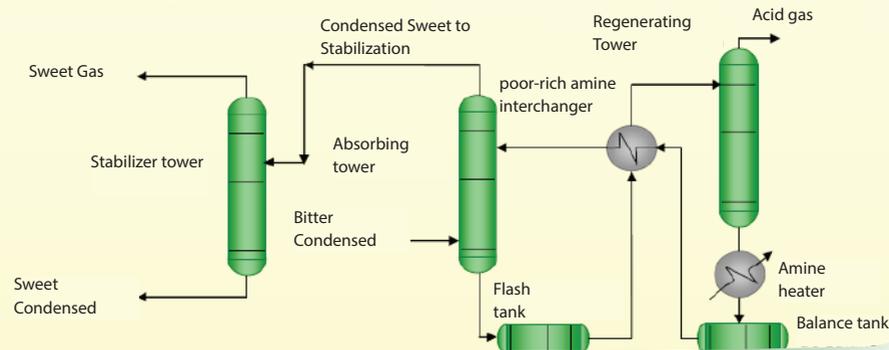
- Stimulation of matrix and by well fracturing
- Studies and technologies for water control in wells
- Organic deposits and mineral scales control
- Technical assistance for lab certification and well testing and facility accreditation

These services are currently offered individually, however they may be combined or provided in combination with other technological services offered by the other Solutions Offices of the Direction of Exploration & Production Services, according to the specific needs of the client.

**Contact:**  
**Surface and Subsurface Facility Solutions Office**  
 Saúl Bautista Fragoso  
 Ph. (52) 55 9175-8297  
 sfragoso@imp.mx



### Sweetening of liquids



#### Evaluation, design and optimization of surface production facilities

Evaluation, conceptual design, and optimization of production facilities, both onshore and offshore.

Analysis of the behavior of well fluids, collection networks, oil-gas-water separation batteries, conditioning fluids, and hydrocarbon transportation systems, using modeling and stationary and/or transitory simulation.

Analysis of fluid flows in:

- Wells
- Collection networks
- Pipeline transportation systems (Dynamic simulation of the behavior of the fluids in the well system-production facilities)
- Definition of exploitation strategies based on the use of the deposit's energy

- Diagnostic and/or conceptual design of hydrocarbon handling and conditioning process
- Dehydration, desalting and stabilization of crude
- Dehydration and sweetening of gas
- Pump stations and compression

#### Fluid measuring systems

Studies and adaptation of methodologies for the client to make informed decisions to implement, improve, and maintain their measuring systems in optimal condition, using the most appropriate technology according to the type of fluid, operating conditions, and degree of accuracy required by the process. In addition, one or more phase measuring systems are offered for implementation based on the results of studies completed.



#### Studies and methodologies

- Development of methodologies in adherence of existing standards to measure hydrocarbon flow, estimate the uncertainty of the measuring, and for the diagnostic, evaluation, and optimization of hydrocarbon flow measuring systems.
- Diagnostic of facilities to determine the flow measuring system needs, the maintenance of existing systems, considering in either case, the development of technical specifications to acquire the infrastructure required, and also the installation of measuring systems.
- Development of specialized software to manage hydrocarbon production at wells and separation batteries by measuring hydrocarbons.
- Design and integration of multiphase GLCC-type measuring systems.
- Consulting and training on the proper use of hydrocarbon flow measuring systems.
- Calculation of uncertainty of measurements to prepare the diagnostic of the current status and propose improvements to the performance of hydrocarbon flow measuring systems.
- Design of test protocols to verify the performance of primary hydrocarbon measuring elements using the multiphase Production and Corrosion Control Laboratory.
- Implementation of single phase and multiphase flow measuring systems and improvement in the performance of single phase hydrocarbon flow measuring systems.
- Design, integration, and maintenance of measuring systems.
- Integration of tank telemetry systems.

#### Flow system and artificial production system studies

This well engineering application determines the conditions for exploitation, modeling the comprehensive reservoir-well production system, selecting, designing, or optimizing production systems performing a technical-economic analysis.

For flowing wells, the flow geometry is designed or optimized for the area around the well and in terms of production.



For artificial production systems, both the surface and subsurface equipment is analyzed.

#### Studies

- Analysis, design, and optimization of flowing production systems
- Analysis, design, selection, implementation, assessment, monitoring, and optimization of artificial production systems (mechanical pumping, gas lift intermittent and continue, progressive cavities, electro-centrifugal and hydraulic submersion, and also systems for the exploitation of gas wells and hybrid systems)
- Economic analysis for the alternative of the flowing system and/or artificial production system selected
- Feasibility studies for the implementation of new technologies
- Monitoring of innovative technologies for artificial production systems (hybrid systems)
- Development of pilot tests for new technologies, for their application under specific conditions
- Integration of validated databases with technical well information
- Analysis of closed wells to define the technical and economic feasibility of their incorporation into field production

**Real time optimization of production processes**

Application of methodologies with a comprehensive reservoir-well-facility approach, to optimize hydrocarbon production processes in real time using modeling and simulation techniques (under steady state and dynamic conditions), to determine the optimal operating points for the critical variables in the process, and feedback the monitoring and control systems for application.

Real time optimization is a technology that can be implemented in an open loop, through operational decisions, or in a closed loop, through decision guided by operator (semiautomatic mode) or totally automatic decisions without an operator.

Analysis of hydrocarbon production processes:

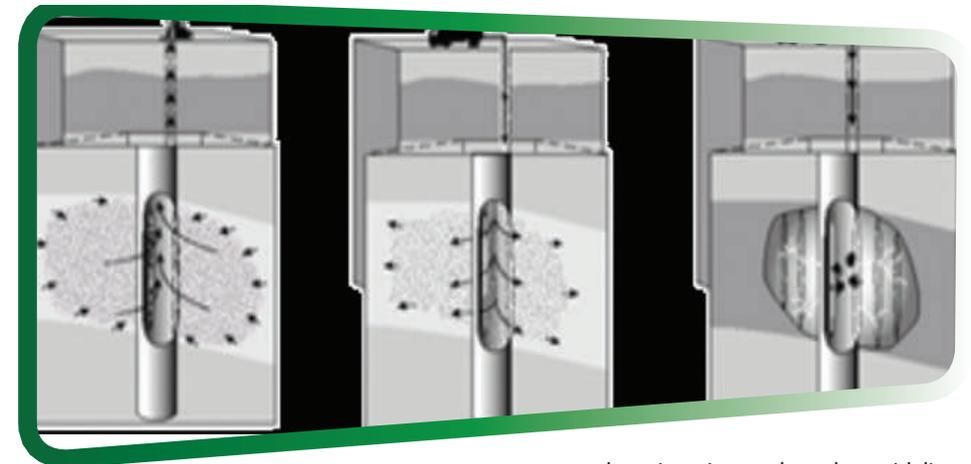
- Deposits (static characterization and numerical simulation)
- Wells (flowing and artificial production systems)
- Facilities (transportation networks, separation, pumping, compression, etc.)
- Definition of reservoir-well-facility optimization strategies
- Analysis of monitoring and control systems to determine the capacities to execute the closed loop optimization strategies

- Study of the measuring systems to quantify the benefit of the implementation of the real time optimization system
- Real time interconnectivity of monitor and control systems, and simulation models (reservoir-well-facility and corrosion)

**Submarine systems and production facilities for deep waters**

Technical assistance in the development of submarine architecture, conceptual engineering, design, construction, installation and optimization of submarine systems, and also assuring the flow and production facilities for deep waters applying current technologies and tools to provide high-tech integral and innovative solutions.

The solutions provided are integrated by well productivity specializations; flowing and artificial production systems; production systems and facilities; submarine production systems; measuring and multiphase pumping; real time optimization of hydrocarbon production processes; digital pipeline, riser, and umbilical monitoring systems, and intelligent well monitoring and control systems.



**Solutions**

- Definition of the deep water field exploitation strategy
- Support group comprised of local specialists, with expertise in the application of VCD methodology in the different disciplines required for the development of deep water fields
- Selection and functional specification of submarine control systems and equipment
- Setting of guidelines for control systems, online optimization and real time data gathering
- Definition of the submarine processing technology
- Supervision of the tender process, engineering, manufacturing, testing, integration, facilities, commissioning, and start-up of submarine production systems
- Design and development of the concep-

tual engineering and tender guidelines for pipeline, riser, and umbilical monitoring systems

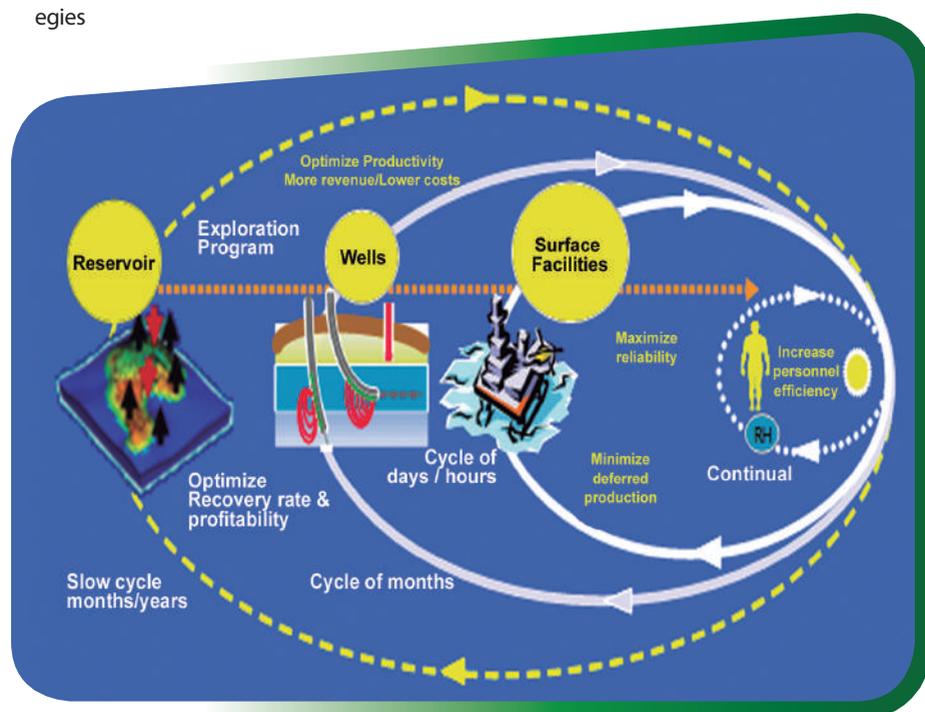
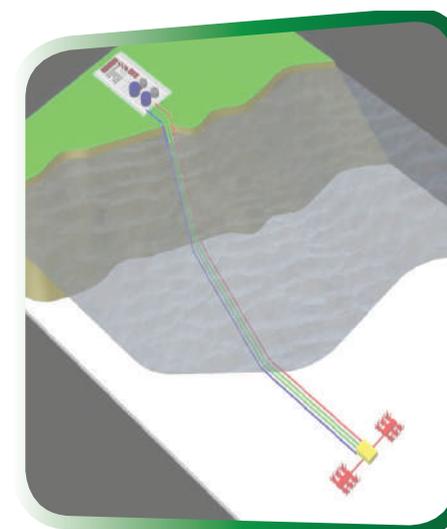
- Monitoring, diagnostic, and evaluation of monitoring, control, and measuring technologies applied at deep water production facilities
- Prediction, prevention, control, and remediation of possible obstructions and/or unstable flow conditions in collection, transportation, and production distribution systems, and also solid control and liquid management in production systems, to reduce the occurrence and impact of operating problems

**Stimulation of matrix and by well fracturing**

This product is for determining the production behavior of the deposit-well system in order to restore and/or enhance productivity. Studies and experimental techniques are conducted where technical and field information is collected, analyzed, validated, and processed together with lab results of rock samples, formation fluids, and treatment systems with the additives employed. The analysis of these results is used to identify causes of low productivity, selecting the ideal solution, and designing the most appropriate treatments.

**Studies**

- Characterization of rocks and fluids
- Well diagnostics
- Treatment selection
- Selection of chemical products for treatment
- Treatment design
- Assessment of the operation and treatment

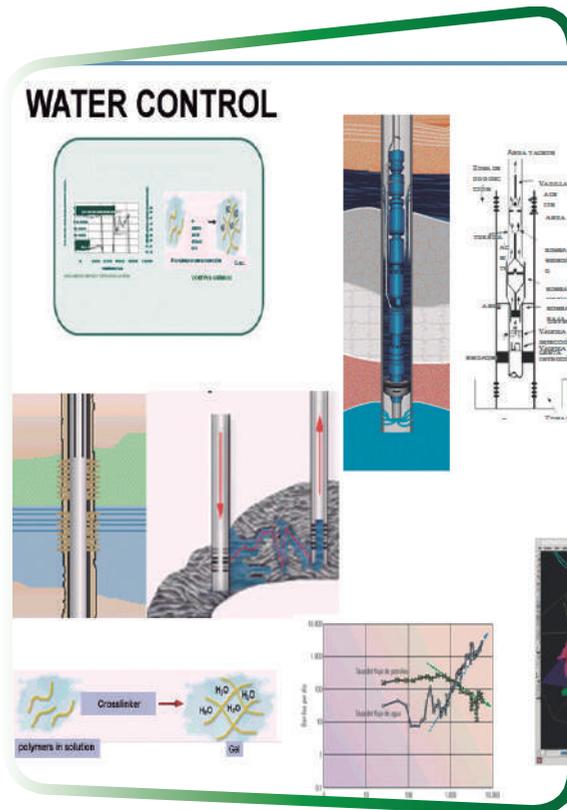


**Studies and technologies for water control in wells**

This product offers comprehensive studies to determine the causes of excess water production in the reservoir-well system, selecting the best control system to maintain the continuity of the operation. The product will provide a water control strategy to restore or increase hydrocarbon production in the reservoir-well system through search, selection, adequacy and application of control technologies.

**Studies**

- Compilation and analysis of technical information
- Bottom hole & Surface fluids sampling
- Physicochemical analysis of water produced
- Isotopic analysis
- Analysis of pressure variation tests
- Analysis of tracer tests
- Development of water flooding charts
- Diagnostic of water flooding
- Assessment of chemical products
- Establishment of optimal technologies
- Economic feasibility of the technology selected
- Monitoring and evaluation of the technology applied



**Organic deposits and mineral scales control**

This technological service determines the incidence level (current or future) of problems of flow assurance in wells and surface production facility system, related to the formation of organic deposits and mineral scales, conducting a series of experimental and numerical modeling studies that together, provide criteria for the detection and control of field problem, including the selection of appropriate technology for this purpose.

**Studies**

- Analysis of technical information
- Sampling and characterization of fluids, deposits, and scalants
- Well diagnostics
- Selection and assessment of technologies for the treatment and control of deposits and/or scales
- Development of a control system for organic and inorganic deposition
- Monitoring and evaluation of the functionality of the technologies applied

**Technical assistance for lab certification and well testing and facility accreditation**

The evaluation, diagnostic, and application of methodologies that contribute to the development of general guidelines for lab certification and test accreditation in the client's laboratories, to substantially improve their operational efficiency, reflected in the quality of the products and services they offer and also in both economic and safety aspects.

This service includes the phases needed for lab certification and test accreditation, starting with a diagnostic of the current operating conditions.

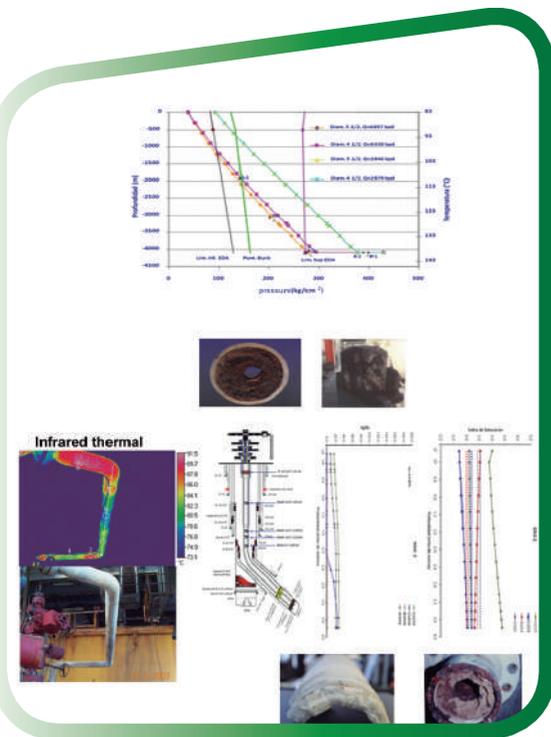
This diagnostic includes a review of the current documentation, to ensure the minimum requirements are met in order to comply with NMX-EC-17025-IMNC-2006 "General competency requirements for testing and calibration laboratories", ISO 9004:2000, and ISO 19011:2002.

**Technical Assistance**

- Diagnostic of the quality management system in terms of both technical and documental aspects
- Preparation of the documentation required for the quality management system, based on NMX EC 17025 and ISO 9001, observing PEMEX's institutional policies
- Preparation of procedures manuals
- Development and implementation of the quality management system
- Development and implementation of systems according to PEMEX's institutional policies
- Planning and execution of quality management system audits
- Designation of the audit team

Quality statistical control activities for testing lab accreditation, including:

- Repeatability and reproducibility studies
- Uncertainty calculation
- Method validation



## Products, Services and Solutions for Well Tools and Systems

IMP offers solutions in the following areas:

- Well drilling, completion, and maintenance
- Systems and tools for gathering and processing well and facility information
- Information systems for exploration and production

### Contact:

Well Tools and Systems Solutions Office  
Armando Méndez Castro  
Ph. (52) 782 826-4725  
amendez@imp.mx

### Drilling, completion and maintenance of wells

Products aimed at the planning, design, evaluation and optimization for the development of oil and gas fields in a profitable and timely way.

#### Product Portfolio

- Well planning and drilling design.
- Design and evaluation of control fluids, hydraulic fracturing fluids and well cementing.
- Planning and design of completion and maintenance of wells.
- Geomechanics and wellbore stability.
- Technical assistance to operations of drilling, completion and well maintenance.
- Planning and design of drilling and completion in deepwater wells

#### Well planning and drilling design

Provide a set of products and services aimed at the planning, design, construction, monitoring, evaluation and optimization of conventional and unconventional drilling; it includes:

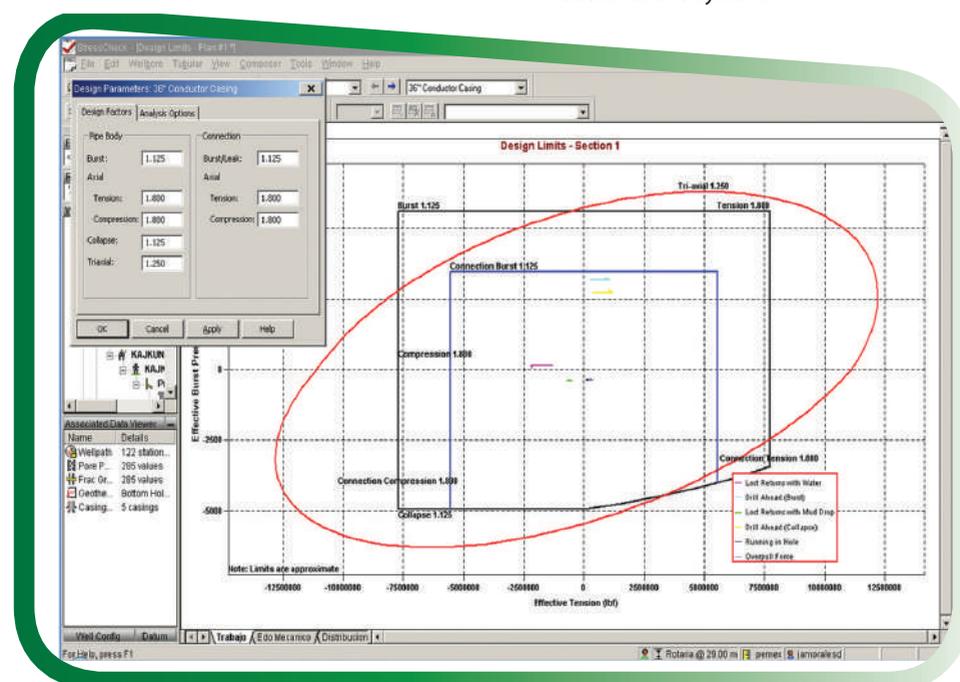
- Geopressures analysis, casing setting depth selection, hole geometry and fluid density control.
- Trajectory of directional and highly deviated wells.

- Drilling bit selection and operation conditions.
- Casing, drillstring and BHA design.
- Hydraulics and well control.
- Drilling rig selection, logistics and cost estimation.
- Lost circulation control through physical modeling.
- Control fluid design and selection vs formation characterization.
- Horizontal drilling.
- Underbalance drilling.
- Special application products.

#### Design and evaluation of control fluids, hydraulic fracturing fluids and well cementing

The objective is to provide a set of products and services oriented to design, selecting, evaluating and optimization of control fluids, its additives and those used in well cementing and fracking, including:

- Fluid system for drilling, completion and workover.
- Selection and evaluation of control solids system.
- Fluid systems for hydraulic fracturing and proppant.
- Miscellaneous services for fluids used in well drilling and completion.
- Systems for primary cementing, squeezing cementing and plug cementing.
- Development, updating, review, approval and issuance of Mexican standards for additives and systems



**Planning and design of completion and maintenance of wells**

The goal is to provide a set of products oriented to planning, design, evaluating, control and/or optimization for well completion and workover that includes:

- Completion and workover design.
- Casing and tubing selection.
- Technology review for drilling and completion.
- Evaluation and diagnostic of completion and workover.
- Non-productive time analysis and technical limit.
- Monitoring and supervision of operations of completion and workover

**Geomechanics and wellbore stability**

The purpose is to provide a set of products and services oriented to analysis and characterization of formations under different stress conditions, also considering well drilling, completion, and workover operations, as well as those effects originated for reservoir exploitation; these include:

- Geomechanical characterization.
- Determination of mechanical properties of rocks.
- Determining the magnitude and direction of the stresses.
- Determination of bore stability.
- Failure criteria evaluation.
- Fluid-rock interaction evaluation.
- Mechanical and chemical stability evaluation of the bore during drilling.
- Physicochemical characterization of formations.
- Analysis and evaluation of special applications (well spacing and number, well trajectory design, hydraulic fracturing, screenout, among others).

**Technical assistance to operations of drilling, completion and well maintenance**

The goal is to offer technical assistance in drilling, completion and well maintenance with specialists to analyze, supervise, evaluate and/or optimize the operating practices for the fulfillment of current regulations and standards.



**Planning and design of drilling and completion in deepwater wells**

The objective is to provide a set of products and services aimed at the planning, design, evaluation and optimization of the drilling and completion of wells in deepwater; it includes the following areas:

- Drilling logistics.
- Shallow hazards management, contingencies and emergencies.
- Pore pressure analysis, casing setting depth selection, trajectory and hole geometry.
- Mechanical and chemical stability evaluation of the bore.
- Determination of bore stability.
- Design and selection of drilling and completion subsea systems.
- Well control subsea systems (BOP's).
- Casing, drillstring and BHA design.
- Hydraulics and well control.
- Selection and evaluation of drilling fluids.
- Analysis, design, and selection of drilling rig and riser.
- Well cementing.
- Unconventional well completions.
- Evaluation of water and sand control systems.
- Well intervention.
- NPT evaluation, drilling bit performance and technical limit.
- Post-mortem drilling analysis.
- Special studies.

**Systems and tools for the acquisition and processing of information of wells and facilities**

Products aimed at the development, evaluation and integration of technologies, tools and systems for the acquisition and processing of technical information from wells and facilities.

**Product Portfolio**

- Modeling of tools for wells and facilities.
- Services of reengineering of tools for wells and facilities.

**Modeling of tools for wells and facilities**

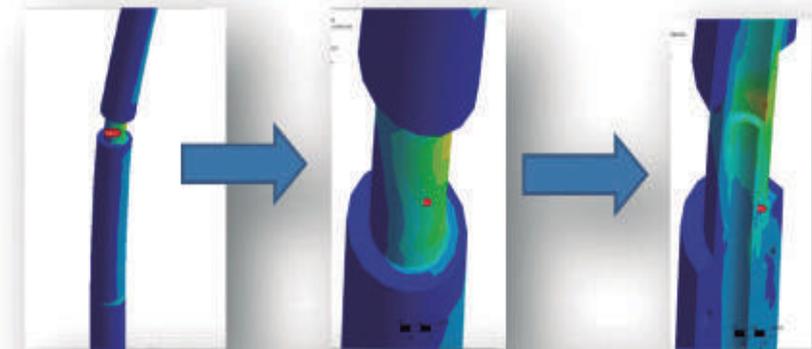
The goal is to provide services oriented to modeling, design, construction and integration of systems and/or tools for gathering and processing of well and facilities information, from the conceptual design, detailed engineering, to the materialization of a functional alternative that allows its vali-

dation and application in the field, including training and technical update activities:

- Conceptual and/or physical design and modeling of systems and tools for the acquisition and processing of information of wells and facilities.
- Integration of systems, equipment and/or tools for gathering well and facilities information that includes, if necessary, reengineering and training.

**Services of reengineering of tools for wells and facilities**

The objective is to provide services oriented to reengineering, installation, commissioning, maintenance, system calibration and training in tools and instruments to acquiring and processing information related with wells and facilities, considering systems developed by IMP or third parties, as well as scaling in volume of systems done and tested by IMP. This services can include:



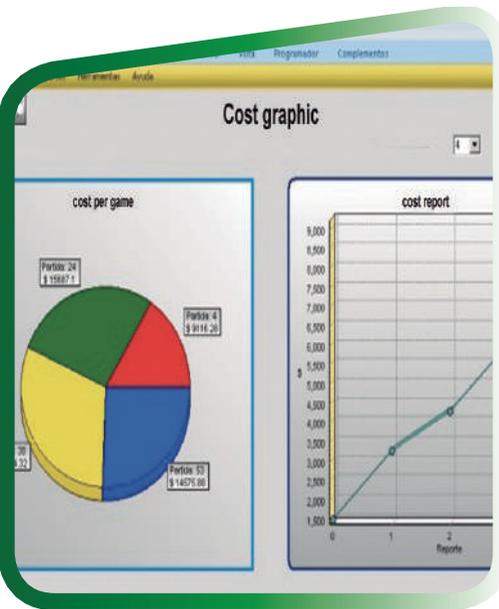
$[K][U] = [P]$  ..... equation 1

Where:

[K] = rigidity matrix  
 [U] = displacement matrix  
 [P] = load matrix

$$\begin{bmatrix} P_1 \\ P_2 \\ P_3 \\ P_4 \\ P_5 \end{bmatrix} = \begin{bmatrix} K_{11} & K_{12} & K_{13} & K_{14} & K_{15} \\ & K_{22} & 0 & 0 & 0 \\ & & K_{33} & 0 & 0 \\ & SYM & & K_{44} & 0 \\ & & & & K_{55} \end{bmatrix} \begin{bmatrix} U_1 \\ U_2 \\ U_3 \\ U_4 \\ U_5 \end{bmatrix}$$

**Dynamic Analysis of the Drilling Riser (Modeling with Finite Elements)**



- Reengineering of systems and/or equipment for acquisition and processing of well and facilities information, such as pressure, temperature, fluid level, etc.
- Maintenance and calibration of systems and/or equipment for acquisition and processing of well and facilities information.
- Training in handling and use of systems and/or equipment for acquisition and processing of well and facilities information.
- Quality control in acquisition of well testing data.

The most important developments in this area include:

- Bottom hole shut-in tool.
- Integral system of measuring well testing (SIMPP®).
- Pressure-temperature tools.
- Venturi-type Flow Pattern Enhancer System (MPFV®).

### Information systems for exploration and production

This set of products includes the development of technical applications and information systems, as well as consulting related with the safeguard and manage oil and gas data.

#### Product Portfolio

- Models and systems for safeguard and manage oil and gas information.
- Information systems in exploration and production.

#### Models and systems for safeguard and manage oil and gas information

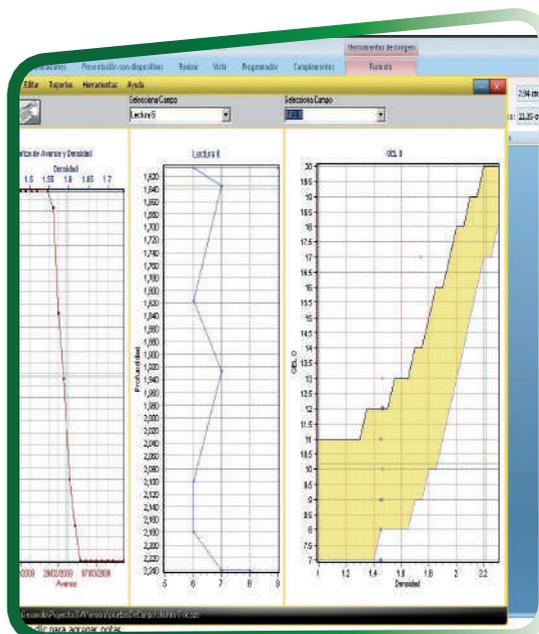
The goal is to generate the procedures and activities, based on technology developments, to analyze, technically validate, safeguard and protect strategic oil and gas data, ensuring its integrity and preservation, contributing with the decision-making of the Exploration and Production specialists. It may include the following steps:

- Models and systems to safeguard well logs.
- Safeguarding of oil data and information.

#### Information systems in exploration and production

Development of services based on the integration, analysis, and interpretation of information and/or data processes related with exploration and production of hydrocarbons, considering for management, development of information systems that allow its management, and are a tool to support decision making. It may include the following steps:

- Integral information systems for exploration and production.
- Development of applications for exploration and production.
- Maintenance, update and support for systems developed with application upon exploration and production.
- Models to generate information for decision-making.



#### Tool to minimize the storage effect during injection tests.

##### Description

The tool helps to minimize the well storage effect during injection tests –fall off test. The results obtained are used to determine reservoir parameters, which are used for decision-making in efficient exploitation of reservoirs.

##### Technical specifications

- Tool is set and released mechanically, using slickline unit.
- Available for tubing since 2 7/8" (6.4-6.5 lb/ft) OD.
- Maximum differential pressure: 7500 psi.
- Maximum temperature: 175 °C.

- Mechanical releasing system.
- Components are interchangeable and of simple maintenance.
- Inner sealing elements to prevent leaks.
- Settled with a mechanical running tool (mechanical anchor).

##### Results

The follow-up actions on the information gathering and the good coordination of the parts involved assures the quality and reliability of the results.

Given the well issues during information gathering, it is important to use the storage effect eliminating tool, which allows a better log interpretation.



### Anchor tool on-tubing for monitoring pressure-temperature

#### Description

The primary purpose of this tool is to register pressure and temperature for long periods of time (months) at the bottom of the tubing, using an anchoring mechanism and hermetic seal that eliminates the well effects, in order to obtain information from the rock-fluid system (damage to the formation, permeability, porosity, median pressure, discontinuities, etc.), through the analysis of variances in pressure, which can be essential for efficient reservoir exploitation.

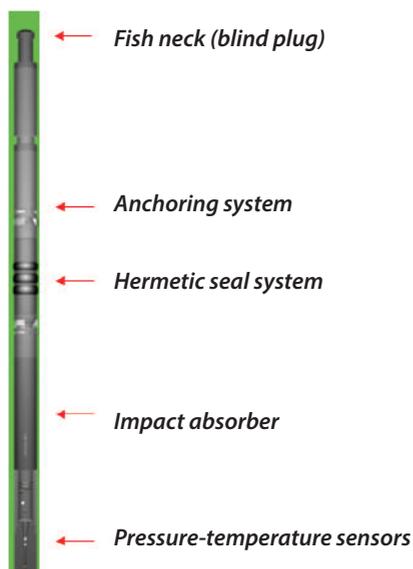
#### Operating principle

The tool is placed at the bottom of the tubing, and includes:

- Anchoring and sealing mechanism
- Impact absorber
- Two pressure-temperature memory probes

#### Technical specifications

- Installed with slickline
- Constructed of AISI 4140 steel
- Maximum pressure differential of 7500 psi
- Maximum temperature 175°C



- The battery life depends directly on the data sampling period
- Its impact absorbing system and protective covering on the memory probes guarantee data recovery
- Available for 2 7/8" (6.4-6.5 lb/ft) and 3 1/2" (9.2 lb/ft) OD of tubing

#### Tools available for pipes:

- 2 7/8" (6.4-6.5 lb-foot)
- 3 1/2" (9.2 lb-foot)

### The Venturi-type flow pattern enhancer system MPFV®

#### Description

The Venturi-type flow pattern enhancer system MPFV® is a mechanical device used in the bottom of production wells to cause a flow restriction. The MPFV® system is also used for:

- Manage the reservoir energy
- Extend the productive life of the well
- Enhance flow conditions and reduce pressure drops in the tubing
- Control the water and sand production
- Prevent or avoid freezing of gas piping with high CO<sub>2</sub> content

#### Technical specifications

- The MPFV® system is set mechanically to the tubing and is released with a slickline unit
- Maximum pressure differential: 7500 psi
- Maximum diameter: 2 3/4" for 3 1/2", 2 1/4" for 2 7/8" and 1 3/4" for 2 3/8" OD of tubing and also coiled tubing
- Maximum temperature 175°C
- Components are interchangeable and of simple maintenance
- Inner sealing elements to prevent leaks

#### Advantages of the MPFV® system vs. con

The MPFV® system has an innovative element (Venturi), located in the fish neck, that:

- Notably improves the flow pattern in the tubing by generating a homogenous dispersion of both phases, for proper transportation from the bottom of the well to the surface

- Reduces pressure drops in the tubing, due mainly to fluid column lightening caused by gas expansion (gas lift effect)
- Considerably reduces the energy required to carry the fluids from the bottom of the well to the separator or compression station

Additional benefits of MPFV® include more stable production (because it prevents the formation of gaps in the tubing).

#### Application Ranges

The wells to be candidates are those with high water cut, intermittent flow or whose production falls down in shortly, or requiring additional help, such as artificial lift. Furthermore, mechanical conditions and properties of the produced fluids must be analyzed and the following requirements must be met:

Parameter	Units	Application Range
LGR	m <sup>3</sup> /m <sup>3</sup>	> 200
Water cut	%	< 70
Setting depth	m	> 300
Oil density	*API	> 15
Maximum deviation	Degrees	< 30
Flowing bottom pressure	kg/cm <sup>2</sup>	Pwf > 50% in weight of the liquid hydrostatic column inside tubing

#### Application in the Burgos Integral Asset

At the end of 2013, there were a total of 310 wells with the MPFV® system at the Burgos



Integral Asset, considering the installation of new tools and the re-use of tools from other wells at the same asset.





[www.imp.mx](http://www.imp.mx)