Program

Exploration in Deep-Water Reservoirs

This course provides an advanced training for exploration geologists and geophysicists focused on understanding clastic sedimentation in deep-water environments, with an emphasis on its relationship with different geomorphological and tectonic contexts. Throughout this course, classic models that have guided hydrocarbon exploration in deep waters from early times to the latest innovative proposals will be reviewed and discussed. Fundamental concepts (i.e., Bouma, 1962; Mutti and Ricci Lucchi, 1973; Walker, 1978; Mutti, 1992; Posamentier and Kolla, 2003; Mutti et al., 2003; Posamentier and Walker, 2006; Zavala and Arcuri 2016; Mutti, 2024) will be revisited, complemented by selected examples from the Pyrenees (Spain), Neuquén Basin (Argentina), Austral Basin (Argentina), Guárico Basin (Venezuela), and Campos Basin (offshore Brazil) to address the issue from different observation scales.

While traditional models have been pillars in hydrocarbon exploration for the last five decades, it is essential to recognize that most models are based on detailed studies of outcrops located in collisional contexts. Applying these concepts to passive margins requires careful analysis, as sedimentary dynamics can vary significantly between active and passive margins. In passive margins, unique features such as low slope gradients, extensive submarine deltas, incised meandering canyons, gullies, levees, transient fans and lobes, as well as a depositional control guided by channel avulsion, MTCs (mass transport complexes), and diapir growth, define a complex depositional environment. The importance and prediction of these last critical elements will be reviewed through selected examples from seismic, well logs, cores and outcrops.

This course comprises five days of immersive virtual theoretical classes and field activities in the Tierra del Fuego Island. During this field trip, participants will have the unique opportunity to explore the impressive Miocene outcrops of the Austral Basin, enriching their understanding with direct observations and discussions focused on comparing theoretical models with the observed rock characteristics.

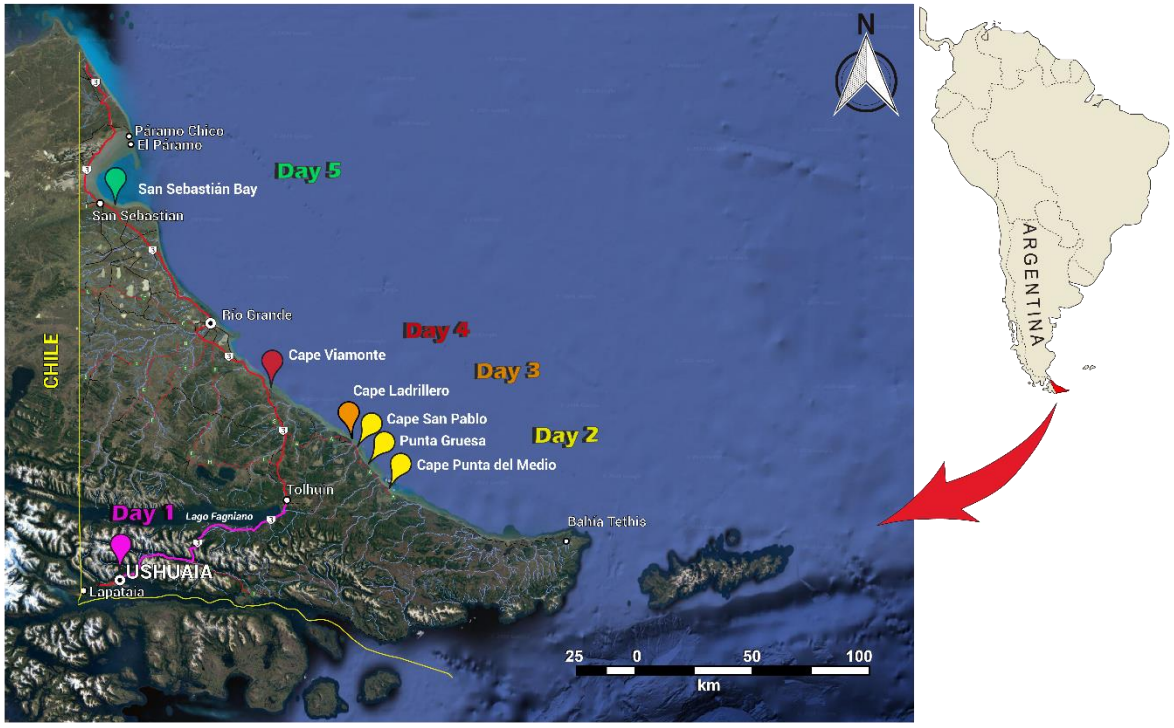


Fig. 1: Location of selected stop areas to be revisited.

Day 1: Introduction & geological setting

- **Departure from Ushuaia (10 am)**
- **Working lunch and introductory class**

Session 1: Introduction to the course and general objectives. Synthesis and geological evolution of the Austral Basin. Stratigraphy and structural context. Main geotectonic units and their evolution.

- **Ushuaia to Tolhuin trip:**

  Exploring the Regional Geology of the Island.

City of Ushuaia

- **Check in Hotel Tolhuin**

- **Thematic session**

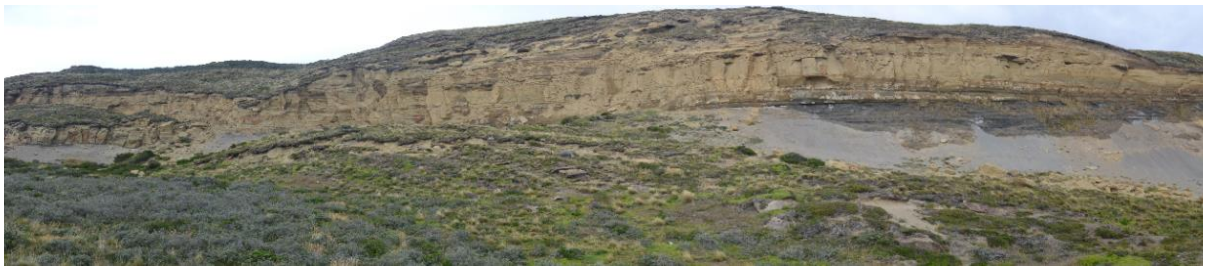
Session 2: Introduction to the analysis of fossil depositional systems and their importance for reservoir analysis. Historical review of fundamental concepts for understanding deep-water sedimentology. Evolution of facies analysis and depositional models applied to reservoir understanding.

Day 2: Classic Models and Recent Advances

- **Location: Tolhuin (Hotel) thematic session**

Session 3: Clastic sedimentation and its processes in deep-water environments. Introduction to facies analysis. Tools for reading the rocks. Facies. Facies sequences and associations. Main sedimentary structures and their significance. Architectural elements. Canyons, channels, gullies, levees, mass transport complexes, and lobes. Muddy and evaporite diapirs.

- **Field trip:** Analysis of spectacular outcrops Anticlinal Campo del Medio, Punta Gruesa, and Cabo San Pablo.



San Pablo Cape

Topics to discuss:

- Origin of massive sandstones and associated deposits
- Facies and characteristics of distal sandy lobes and slope fans (transient fans).
- Distinction between axial and lateral deposits (levee).
- Prediction of the extent of sandy deposits from facies analysis
- Evolution of models applied to hydrocarbon exploration.

- **Return to Tolhuin**

Day 3: Channel and Lobe Systems

- **Location: Tolhuin (Hotel) thematic session**

Sesión 4: Types of gravity flows in nature and their deposits. Recognition in outcrops, cores, and well images. Cohesive debris flows. Hyperconcentrated flows. Concentrated flows. Sediment-laden turbulent flows. Intrabasinal and extrabasinal (hyperpycnal) flows. Episodic and quasi-steady flows. Flow fluctuations. Contour currents.

- **Field trip:** Visit to the outcrops in the area of Cabo Ladrillero

Topics to discuss:

- Channel-lobe transition along the slope
- Characteristics of “mass transport complex” deposits
- Characteristics and significance of clastic injectites.
- Origin and significance of massive sands with whole leaves.
- Case study on model applications in different geological contexts.

Cabo Ladrillero

- **Return to Tolhuin**

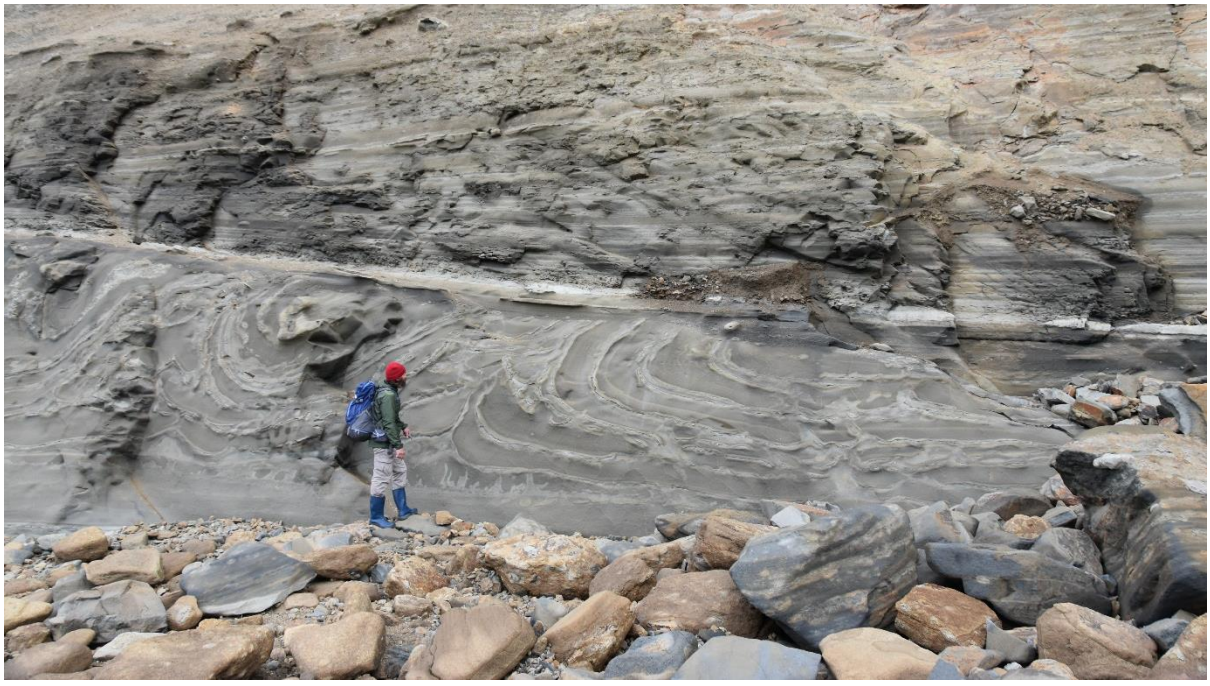
Day 4: Canyons, Channels, and Gullies

- **Location Tolhuin (Hotel) thematic sessions**

Session 5: Intrabasinal and extrabasinal turbidites. Characteristic facies. Depositional models for intrabasinal turbidites. Processes and facies. Extrabasinal turbidites. Depositional models and characteristic facies associated of hyperpycnal flows. Extrabasinal turbidites and deltas.

Session 6: Turbidite systems in collisional margins and passive margins. Current models and their application to reservoir analysis and prediction. Exploration in submarine canyons and slope areas. Transient fans. The fill and spill model. Turbidite depocenters in minibasins. Examples.

- **Hotel check-out**
- **Field trip:** Visit to the outcrops of Cabo Viamonte.



Viamonte Cape

Topics to discuss:

- Observation and analysis of the internal complexity of canyon fills
- Multiple channel incisions
- Terraces in submarine channels
- Analysis of the facies transition from channel to levee areas
- Seismic data and well logs analysis to identify key geological features

- **Arrival to Río Grande:**
- **Hotel check-in**

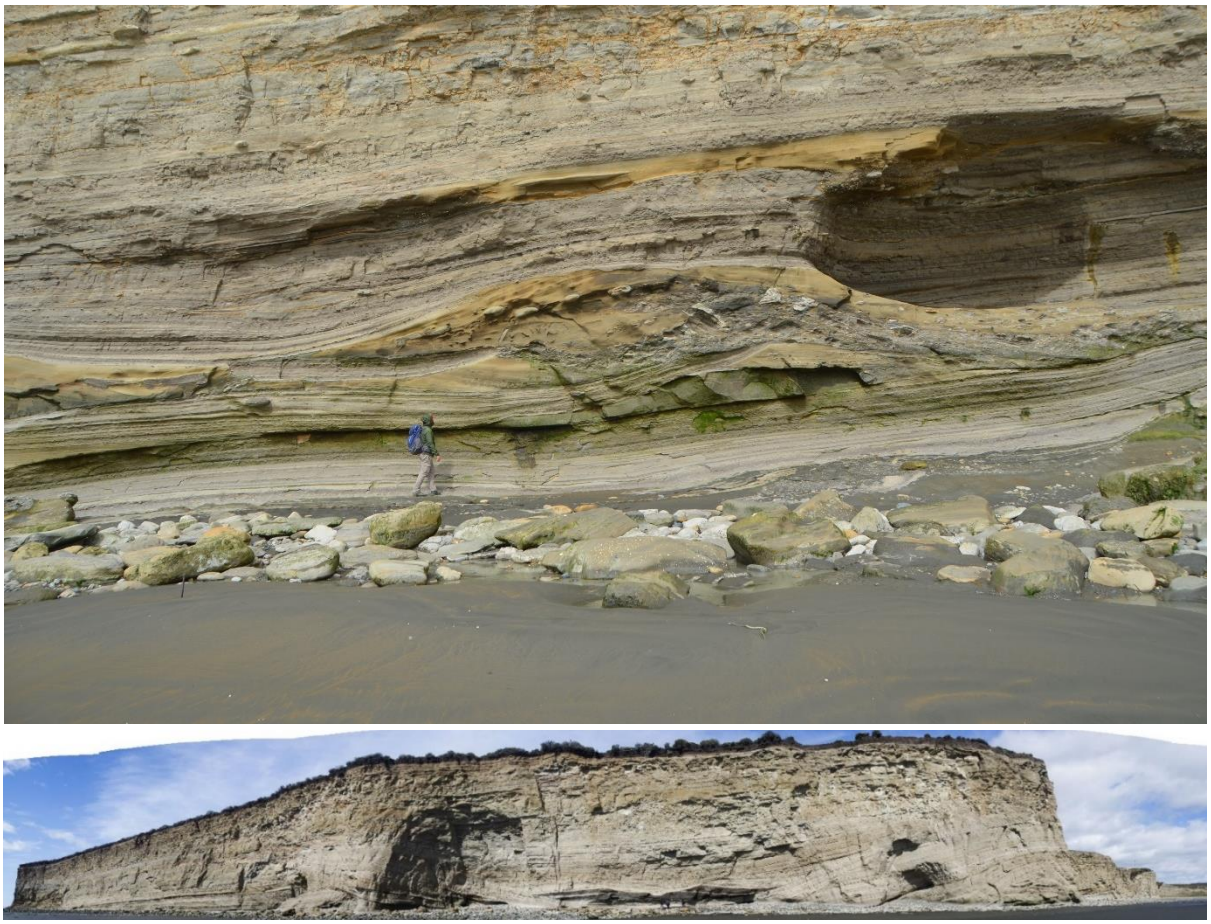
Day 5: A Transect Along a Slope Front

- **Location Rio Grande (Hotel) thematic session**

Sesión 7: Global examples of turbidite systems in collisional margins and passive margins. Analysis and proposals of exploratory models using seismic attributes complemented with core and electric log analysis. Application of machine learning and Computer Vision Techniques (CVT) for reservoir analysis and prediction. Creation of robust, predictive, and applied static models.

- **Field trip:**

Visit to the outcrops of San Sebastián bay and Cabo Santo Domingo.



San Sebastián bay

Topics to discuss:

- Analysis of the transition from the shelfal margin to the base of slope in an exceptional extended and continuous outcrop.
- Facies and geometries in prograding slope clinoforms.
- Multiple cut and fill surfaces (gullies).
- Channel fills. Lateral accretion deposits in meandering channels.
- Turbidite canyon infill
- Core interpretation and comparison with theoretical models.

- **Arrival in Rio Grande:**
- **Closure dinner and course certification**

Day 6: Return home

- **Hotel check-out and transfer to Ushuaia (arrival at noon)**

Summary of Thematic Sessions "Theory"

Session 1: Introduction to the course and general objectives. Synthesis and geological evolution of the Austral Basin. Stratigraphy and structural context. Main geotectonic units and their evolution.

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