N102: Deepwater Slope Channel Complexes: Architecture and Evolution to Distal Facies *(South and East Turkey)*

Instructor(s): Bryan Cronin and Hasan Celik

8 Days	Competence Level: Skilled
Field Course	
Classroom Elements	
HIGH	High Physical Demand

Summary

Cenozoic basins of Southeast Turkey host spectacular deepwater clastic systems and, therefore, are excellent analogues for the improved understanding of slope channel complexes. The exposures analysed on this course include: architectural components, such as sand and gravel-filled slope channel complexes; exhumed canyons; debris flows and mass-transport complexes; gravel-dominated slope aprons; mud, sand and gravel-filled channels; leveed channels, traceable to over-bank deposits for hundreds of metres.

Learning Outcomes

Participants will learn to:

1. Evaluate the shelf to basin transition of alluvial fan-fan delta- deepwater (conglomerate and sand rich) fans.
2. Assess lateral and vertical relationships between conglomerates in deepwater and their enveloping coeval facies.
3. Judge the role of tectonically driven sea floor topography in fan depocentre distribution and fan sourcing.
4. Assess deepwater channel fills through synsedimentary sea floor topography and the resultant complex channel fill architectures.
5. Evaluate the relationship between channel fill and channel overbank sands.
6. Formulate ideas of canyon fills and their relationship to the channel complexes.
7. Construct a sequence stratigraphic model of deepwater systems, recognising maximum flooding surfaces, incised valley equivalent surfaces and the change in architectural style with changes in sea level.
8. Compose models for high, moderate and low net:gross confined slope channel complexes.
9. Judge the relationship/interaction between channels and fold developments.

Duration and Training Method

An eight-day field course in Southern and Southeastern Turkey, conducted principally in the field, with some informal evening discussion and morning lecture presentations on most days.

Physical Demand

The physical demands for this class are HIGH according to the Nautilus Training Alliance field course grading system. A good to high level of fitness is required for this class. There are many long walks, often over tough terrain, with the longest being nearly 9 km (5.5 miles), over undulating ground, throughout the day. Almost every day there is a hike over 1.6 km (1 mile). There is an afternoon spent on a boat, combined with over 1200 miles of driving throughout the week - participants who experience motion sickness are advised to take appropriate medication. Many locations are remote and susceptible to the extremes of weather in particular heat.

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Who Should Attend

This course is designed for experienced geoscientists interested in deepwater clastic systems. It is particularly relevant to geoscientists interested in slope systems and channel architectures.

Prerequisites and Linking Courses

Whilst there are no formal prerequisites for this class, it is assumed that participants have a good understanding of deep water systems, be that through their own work or through other Nautilus courses.

A basic understanding of deepwater systems can be sought through a number of Nautilus Training Alliance courses including, N155 (Introduction to Clastic Depositional Systems: a Petroleum Perspective) and N009 (Sedimentology, Stratigraphy and Reservoir Geology of Deepwater Clastic Systems).

Participants can also take a number of additional deepwater field courses at Skilled Application Competence Level. Those interested in understanding the influence of structural controls on deepwater clastic systems may wish to attend N028 and N056 (Northern Spain). Those interested in exploring upper-slope systems and channel architectures further could attend N315 (Deepwater Slope Canyons and Channel Complexes of Southern and Central California). N107 visits the Karoo, South Africa to view lower-slope and distal architectures whilst N033 (Spain) focuses on modelling and development planning in deepwater systems.

Course Content

Two of the Turkish turbidite basins have almost complete exposure from shelf break through slope and into basin floor fans exposed on the scale of the Brushy Canyon sections in west Texas. Some of these basins contain remarkable 2D and 3D sections through some of the most elusive architectural settings, including:

- 50 km section down a deepwater trough-fill which is exhumed and untectonised
- 100's of metre scale exposures of gravel-filled deepwater canyons
- Kilometre scale exposures of sand, mud and gravel filled slope channel complexes
- Onlap surfaces that rival those of the Grès d'Annot turbidites of southern France
- Leveed deepwater channels to overbank, traceable for many hundreds of metres
- Huge debris flows and base-of-slope slide sheets which control overlying external sandbody geometry

Course itinerary

Day 0

Travel to Adana, Turkey. Participants are asked to arrive in by 18:00 for an optional group dinner in Adana at about 20:00.

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Day 1 -2

After a night in Adana, southern Turkey, we spend two days in the Cingoz Formation, Adana Basin. After a short introduction to the area and safety briefing, we head out into the field.

Study of a bypass deepwater clastic system, filling a 7 x 50 km long topographically confined trough-shaped basin which contains sandy and gravely confined sheets with lobe and tongue geometries, laterally confining marly and muddy slope/base of slope muddy debrites and slide sheets.

The Cingoz Formation is a Miocene deepwater clastic system. One main and several smaller deepwater 'fans' bypass partially coeval platform carbonates into deepwater, are confined to the south by basin floor topography. The fans migrate eastwards in front of distal reef and deepwater slope sediments, propagating in front of the northern basin margin. The clastics are sand to conglomerate grade, can be traced up palaeoslope into fan delta and alluvial fan sediments on the (restricted) shelf, and mapped 50 km down dip. The sand body geometries in the main deepwater clastic system include canyon elements, trough-fill elements, lobes and 'tongues' and can be compared downdip. The system pinches out north and south on steep and low-angle palaeotopography, respectively.

Key elements of this two-day excursion:

1. Shelf to basin transition of alluvial fan – fan delta – deepwater (conglomerate and sand rich) fan.
2. Examine the lateral and vertical relationships between conglomerates in deepwater and their enveloping coeval facies.
3. Fan sourcing: are conglomeratic fans fed as a linear apron or axially from a different point source?
4. The role of tectonically-driven sea floor topography in fan depocentre distribution.
5. Conglomerate/sand rich deepwater fan architecture in dip and strike aspects (if time allows).

Days 3 - 5

Day 3 starts with a drive to the Maras Basin. The Maras Basin comprises three major incised slope canyons with very coarse fills, the largest of these being 350 m thick and 2.5 km wide. This basin margin is also characterised by very thick sandy debrites and mud slide complexes, indicating an extremely tectonically active margin. The northern basin margin is unique among the three turbidite basins visited, with thick accumulations of mass-transport complexes. In the Lice Formation, Maras Basin we study deepwater canyons, associated overbank 'wings', debris flows, slumps, confined basin, lobes, and slump scar fills.

The Lice Formation in the Maras Basin is Miocene in age and partially coeval with the Cingoz. The Alikayasi Member is a 350 m high, exhumed conglomerate filled deepwater canyon, which is almost 9 km long as it is presently exposed. We pass through various examples of deepwater clastic elements which are marginal to the canyon, including deepwater slope channels (some of them leveed), synsedimentary slumps and debris flows, thick sandy overbank packages related to the main canyon. We pass through a world-class example of a deepwater canyon, exposed with its laterally-coeval slope elements.

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On the northern margin of the Maras Basin, examining sheet, lobe and debris flows in the distal and medial parts of the system. The Tekir Member within the Lice Formation is another sand and conglomerate-filled canyon, which is exposed as an excavated valley running NW-SE, towards the northern margin of the basin. We drive up through the exhumed canyon fill towards the shelfbreak in a second spectacular canyon drive-through. The day ends with a 4 hour drive to Elazig, stopping off at some culturally interesting points en route.

Days 6 - 8

The Elazig Basin contains numerous slope channel complexes. These entrenched deepwater slope channel complexes are directly analogous to deep-water GOM (Plio-Pleistocene plays), deepwater Angola (mid-Cenozoic), Mauritania (Cenozoic), Nile (Plio-Pleistocene). Channel complexes range in width from 500m to 6 km, and in thickness from 75 m to 300 m. They are either sand/gravel prone, or mud prone. All have complex fills revealing phases of re-occupancy, including very deep reactivation. They also contain sinuous deepwater channel elements towards the top - one of the most elusive relationships yet for outcrop-based geoscientists to have tracked down.
In the Kirkgecit Formation, Elazig Basin, eastern Turkey we observe leveed deepwater channels, overbank sediments, HARPS, connectivity between channel elements, deepwater slope, debris flows, distally-steepening ramps, mud-filled channels, perched basin fills, and slump scars.

The Kirkgecit Formation comprises the fill of a northeast-southwest striking basin, the Elazig Basin, which consists of deepwater and shelf sedimentary facies. The sedimentary fill of the basin accumulated when the basin subsided rapidly during the Middle Eocene by block faulting within a backarc setting. The Formation is exposed over a large area. The Kirkgecit Formation in the Elazig area is characterised by shelf facies (calcarenites, shelf sands) to the north and by slope and basin plain facies to the south. Facies associations such as inner, middle and outer fan, slope, basin plain, carbonate shelf and shelf-front carbonate are identified west of Elazig. The northern margin of the basin was strongly affected by tectonics.

Channels in the Kirkgecit Formation are characterized by a steep deepwater slope. Sand and conglomerate-filled leveed deepwater channels formed a tributary network on the slope. This area has some world class examples of deepwater channels where the channel-fill, levee and overbank sediments can be walked out directly. We examine sand sheets in the overbank area, interpreted as HARPS, which are physically dislocated from the main channel axis by synsedimentary slumps.

The reconstruction of slope and associated turbidite and mass-flow units in the Baskil area within two slope basins compares different parts of the northern margin of the Kirkgecit Formation. Injected sands and conglomerates are seen at one locality at the margin of a spectacular channel.

A traverse through a major deepwater channel, confined by synsedimentary sea floor topography, reveals a very complex channel fill architecture, which is subsequently modified by settling of the channel body in the subsurface. Evidence for injection of sand is seen. A final traverse through yet another channel system shows breaches in the levee, filled with coarse slurried facies which might give connectivity between

channel fill and channel overbank sands. The channel architecture is examined and the history of channel filling by reactivation discussed.

Day 9
Participants are free to depart Elazig.