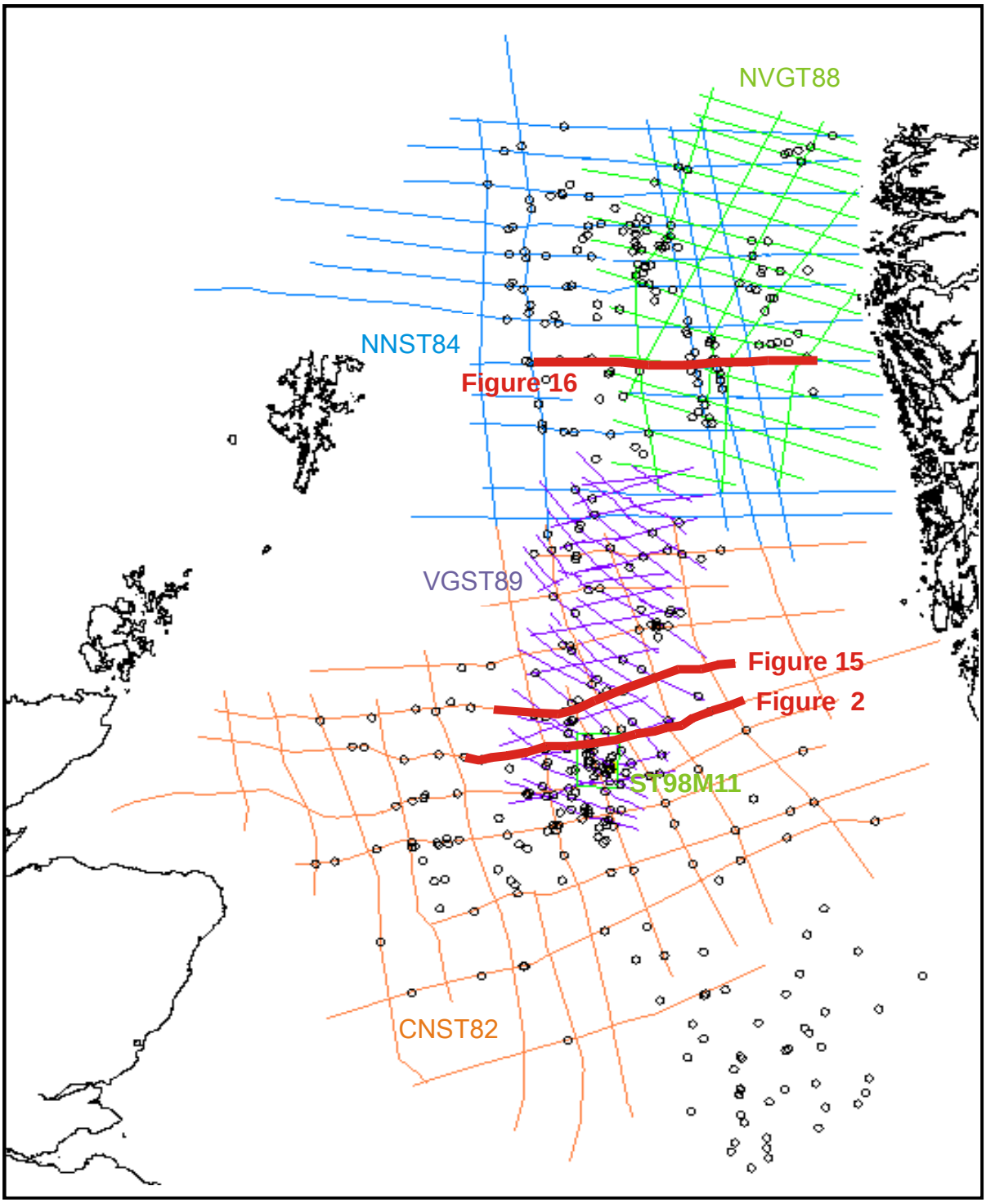


Figure 1 Regional seismic and well datasets. Bold red lines denote geoseismic sections.

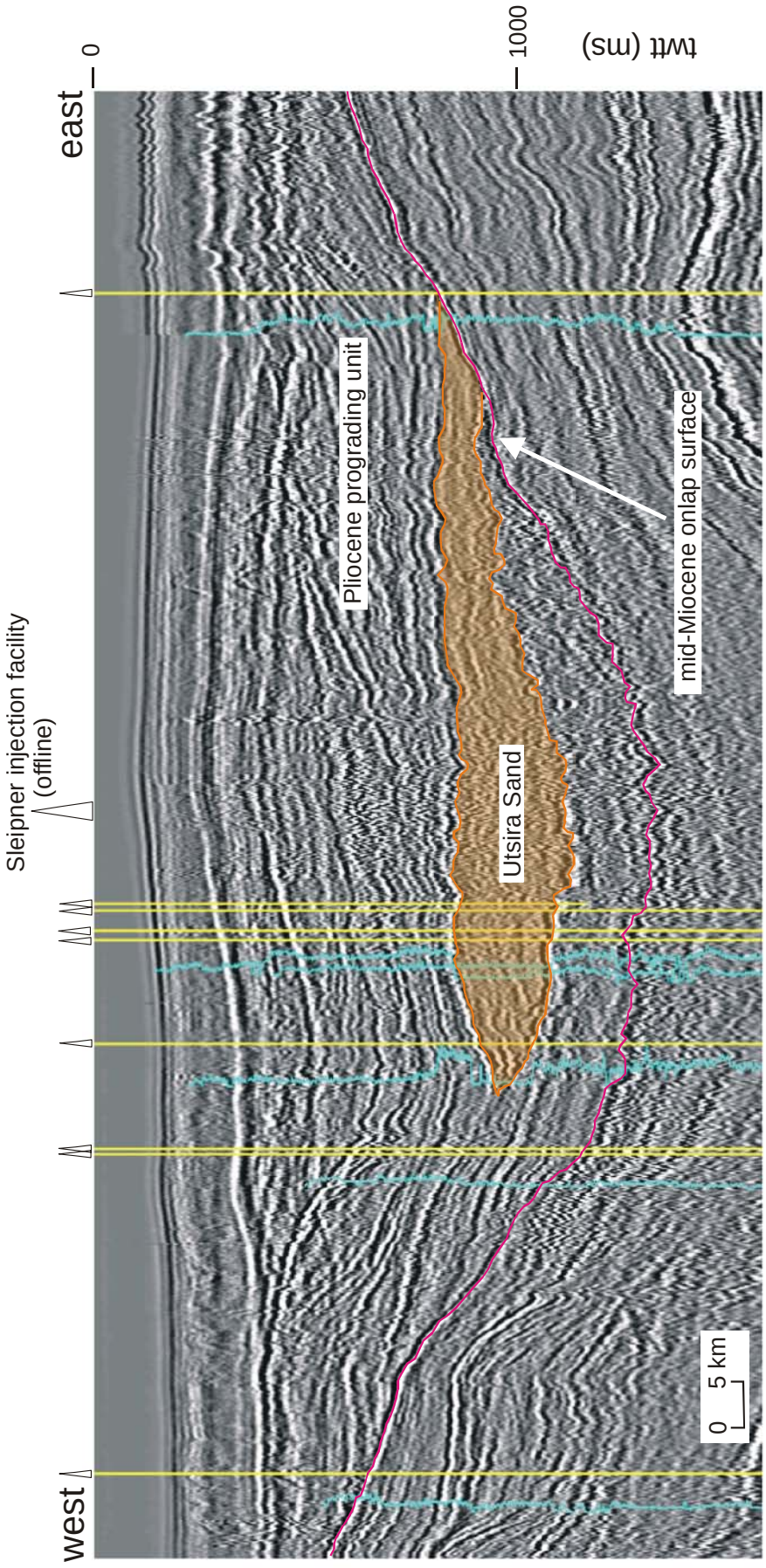


Figure 2. Seismic section across the southern Utsira depocentre, close to Sleipner (see Figure 1 for location).

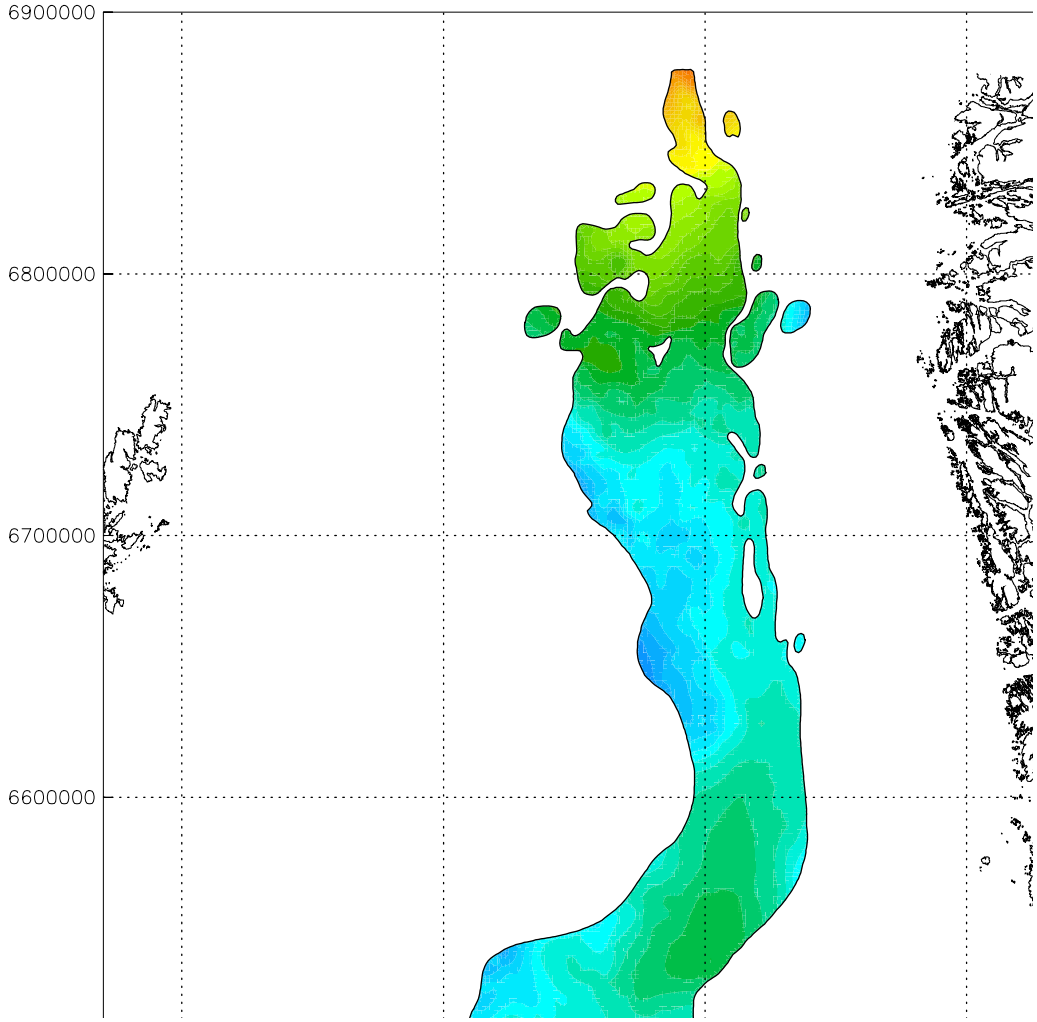


Figure 3. Depth map to top of the Utsira Sand (scale in metres below OD). Dot denotes CO_2 injection point.

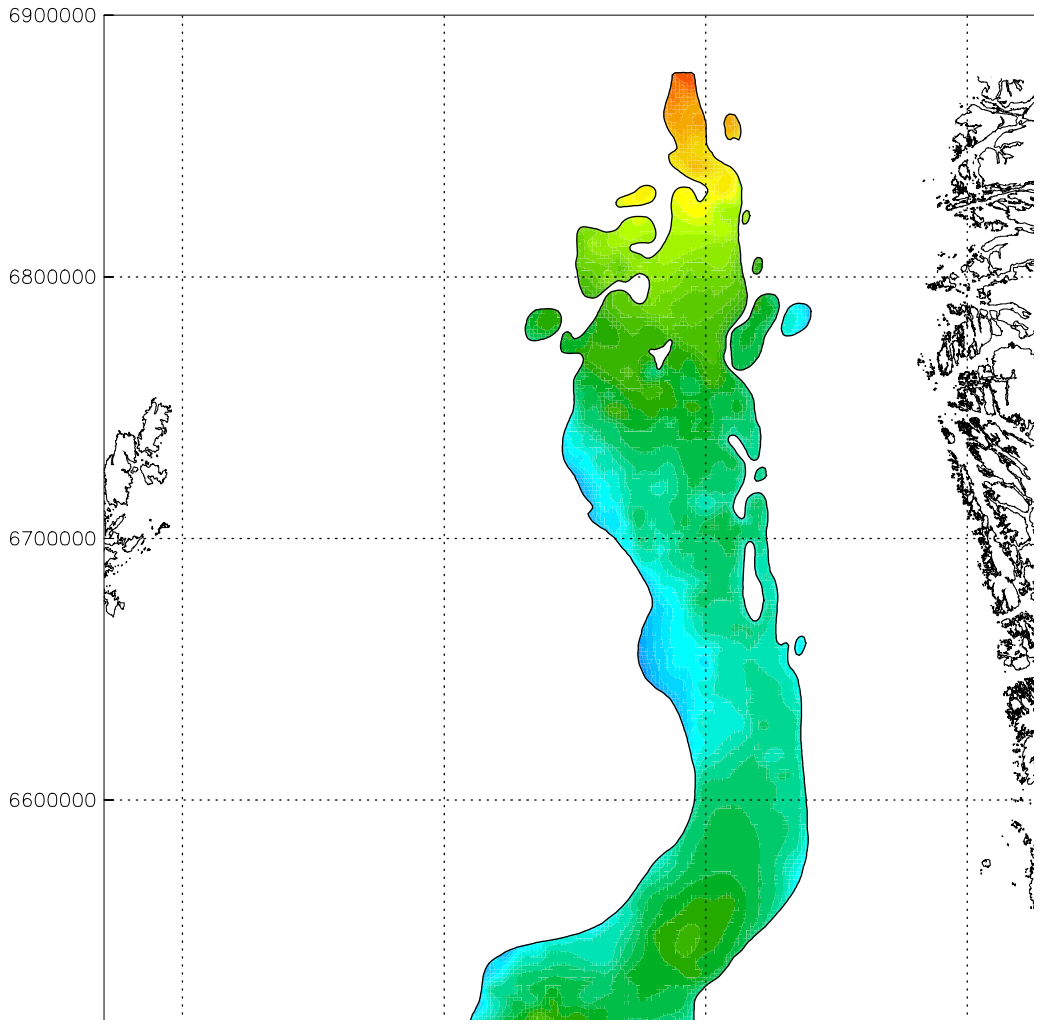


Figure 4. Depth map to base of the Utsira Sand (scale in metres below OD). Dot denotes CO_2 injection point.

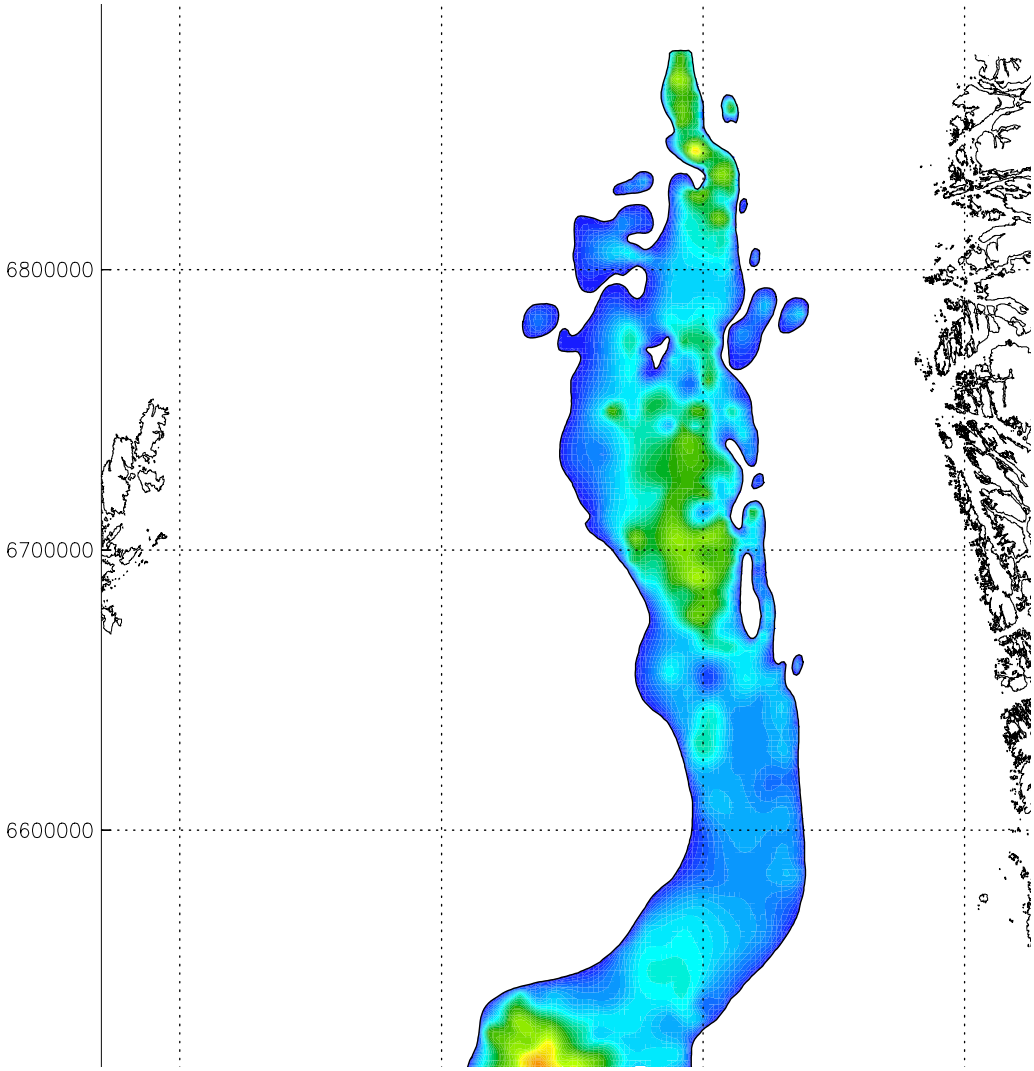


Figure 5. Isopach map of the Utsira Sand (scale in metres). Dot denotes CO_2 injection point.

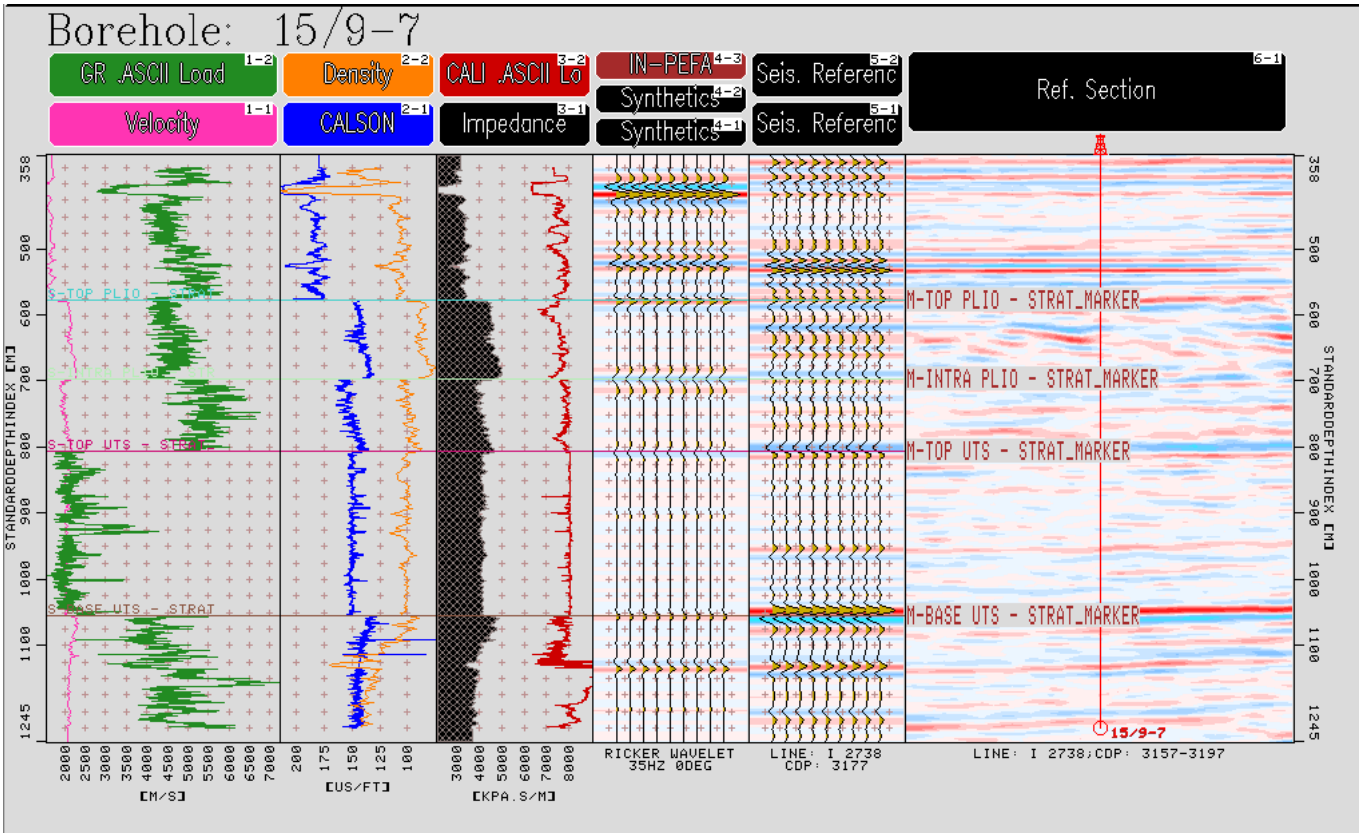


Figure 6. Synthetic seismograms derived from well log data (Norwegian well 15/9-7) compared to the actual seismic data.

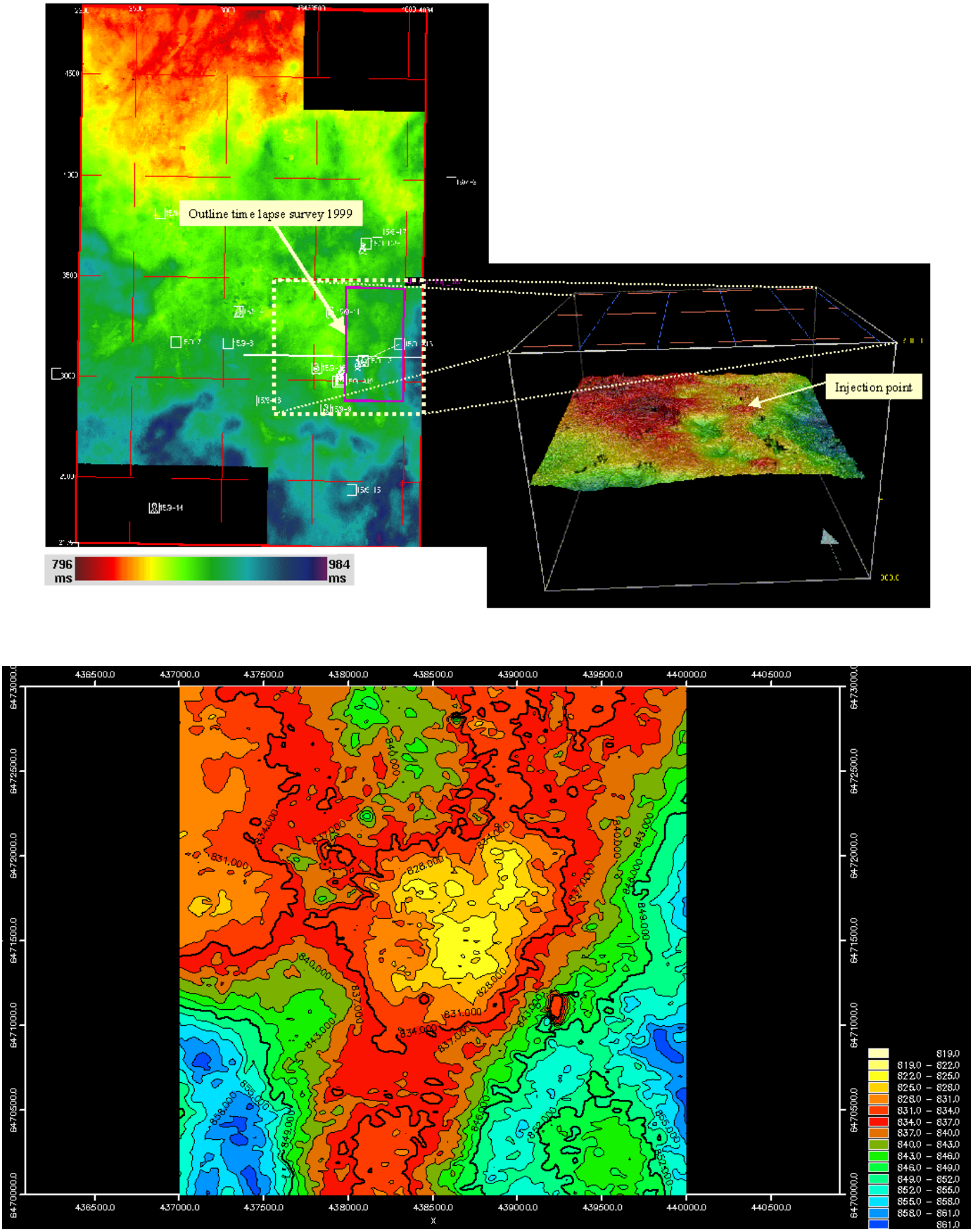


Figure 7. 3D seismic survey ST98M11, showing two-way time map of Top Utsira Sand and perspective view (top). Depth map to top Utsira Sand around injection point (bottom).

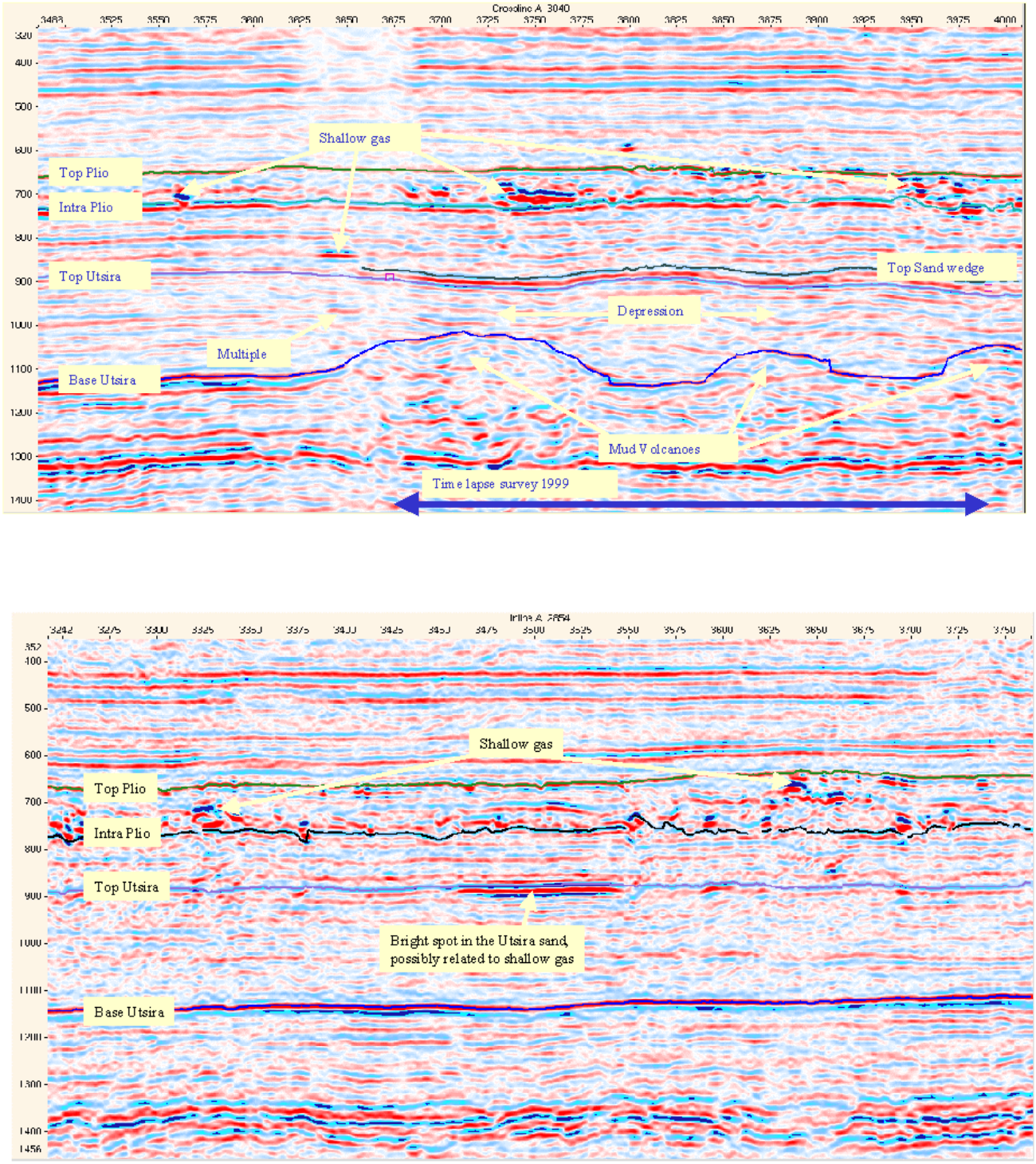


Figure 8. Seismic crossline (east to west)and inline (south to north) from survey ST98M11. Mud-volcanoes at the Base Utsira Sand are observed. Note the depressions just above them due to differential compaction. Amplitude anomalies possibly linked to the presence of shallow gas are observed in the thin shale drape just above the Top Utsira Sand in the lower Pliocene and also in the upper Pliocene.

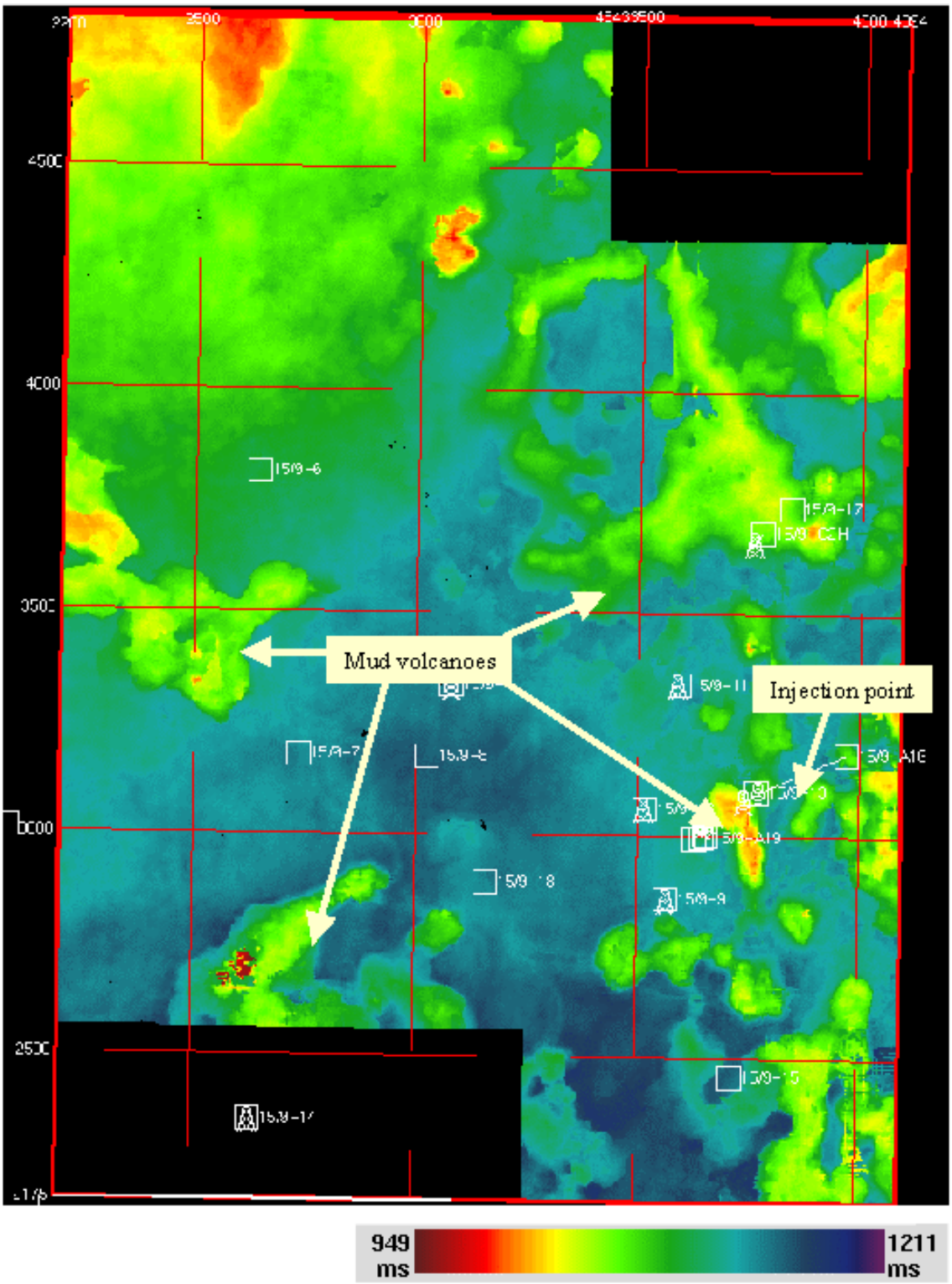


Figure 9. 3D seismic survey ST98M11, showing two-way time map of Base Utsira Sand. Note mud volcanoes.

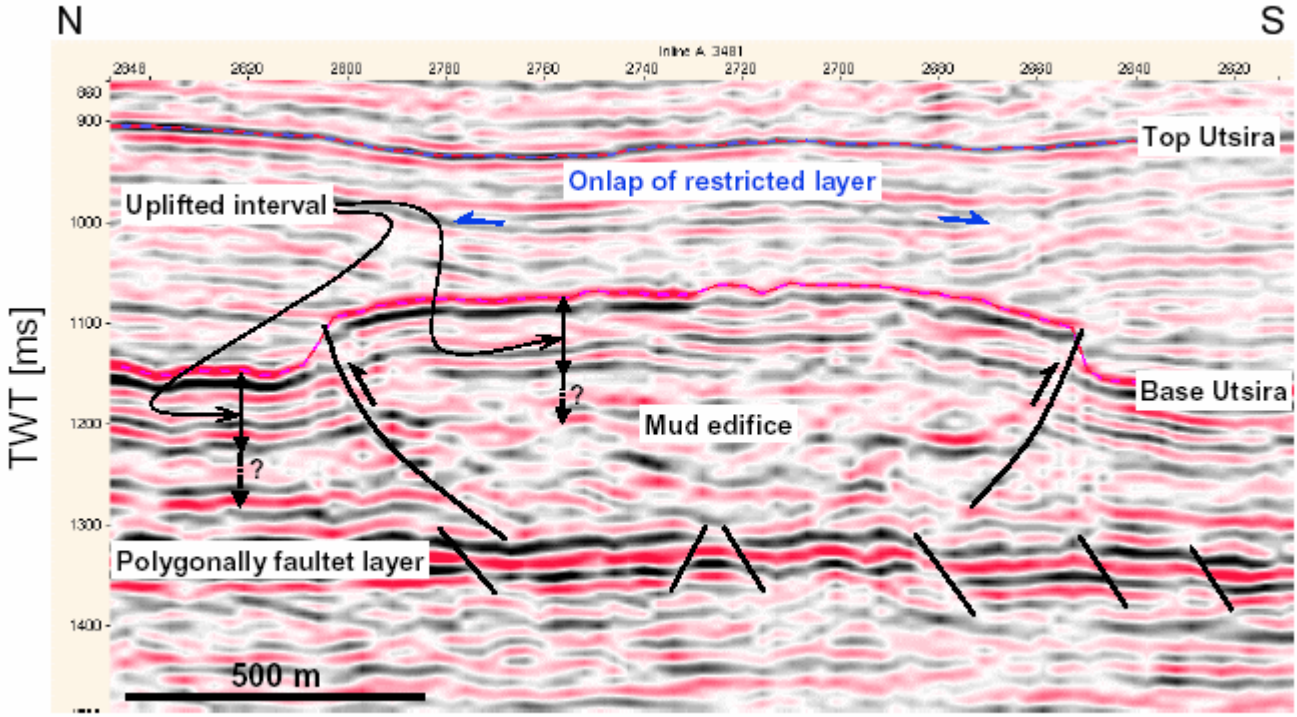


Figure 10. Seismic inline showing 'pop-up' mud edifice, bounded by reverse faults. Note the identical seismic signature of the top part of the shales within and outside the mud edifice. Faults do not continue into the Utsira sand above the top level of the uplifted shales. The deeper shale layer, affected by polygonal normal faulting, has not been affected by the reverse faults.

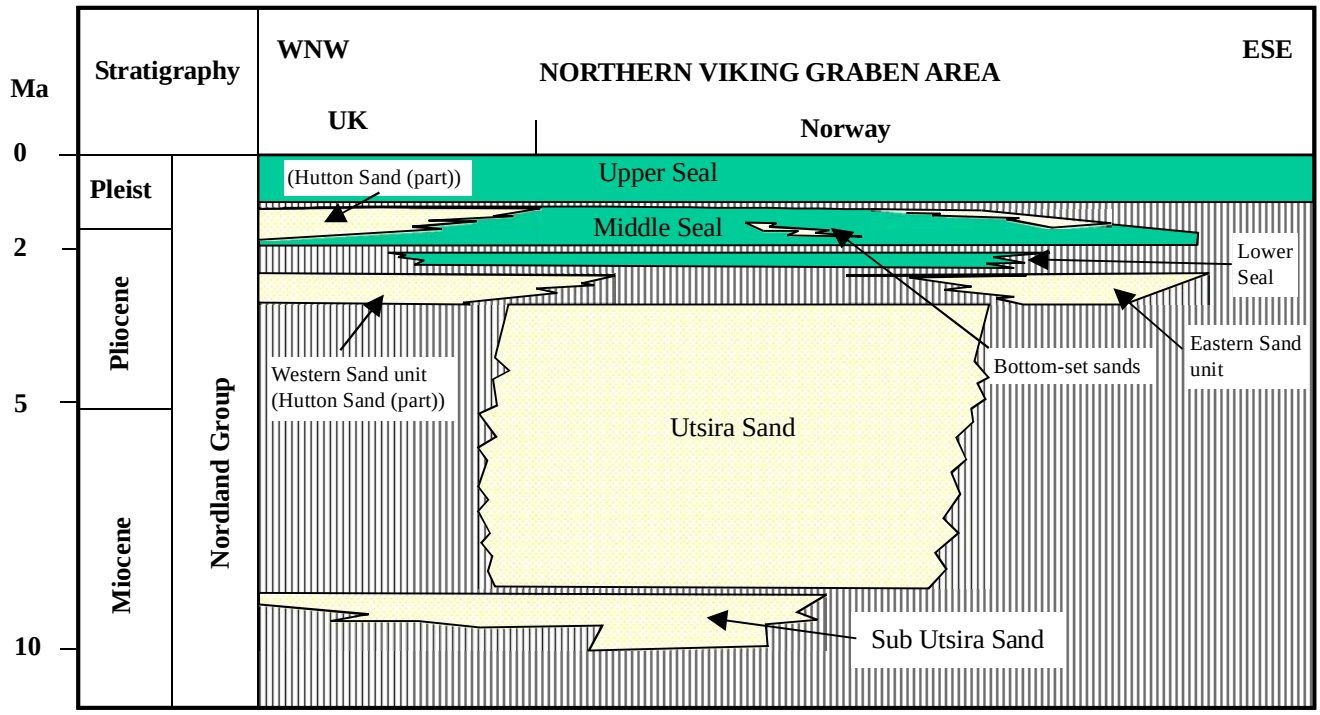


Figure 11. Generalised stratigraphy of the Neogene of the northern North Sea. Principal sand units highlighted.

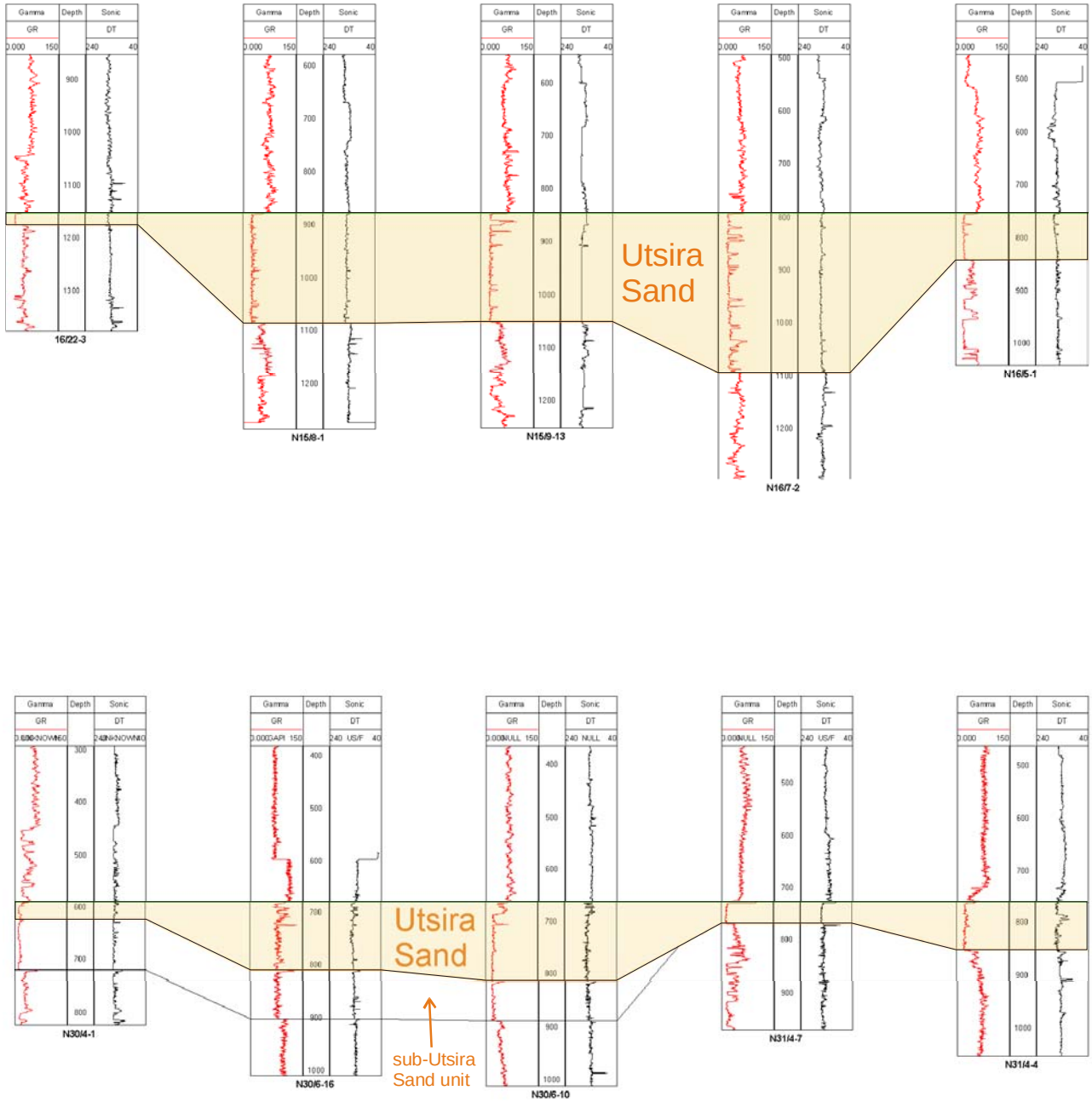


Figure 12. Regional well correlation diagrams a) through the Utsira southern depocentre. For simplicity the Sand-wedge is included within Utsira Sand. b) through the Utsira northern depocentre. Note the sub-Utsira Sand unit in the north.

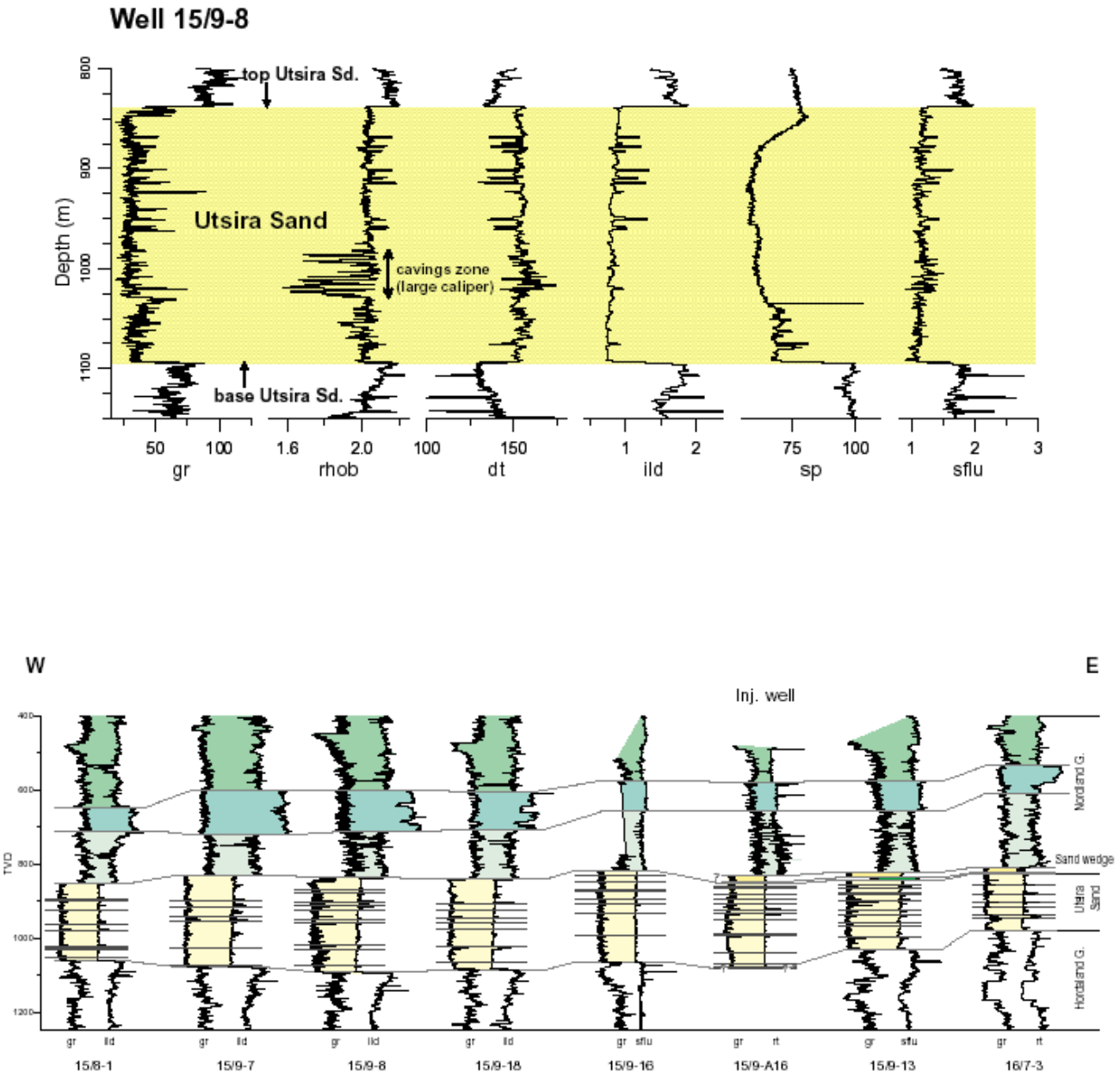


Figure 13. a) Detailed well logs through the Utsira Sand, showing a number of thin shale beds (Norwegian well 15/9-8). b) E-W well correlation diagram through the Utsira Sand and its caprock in the Sleipner area. Note the thin intra-reservoir shales and the Sand-wedge in the lowermost part of the caprock, pinching out to the west.

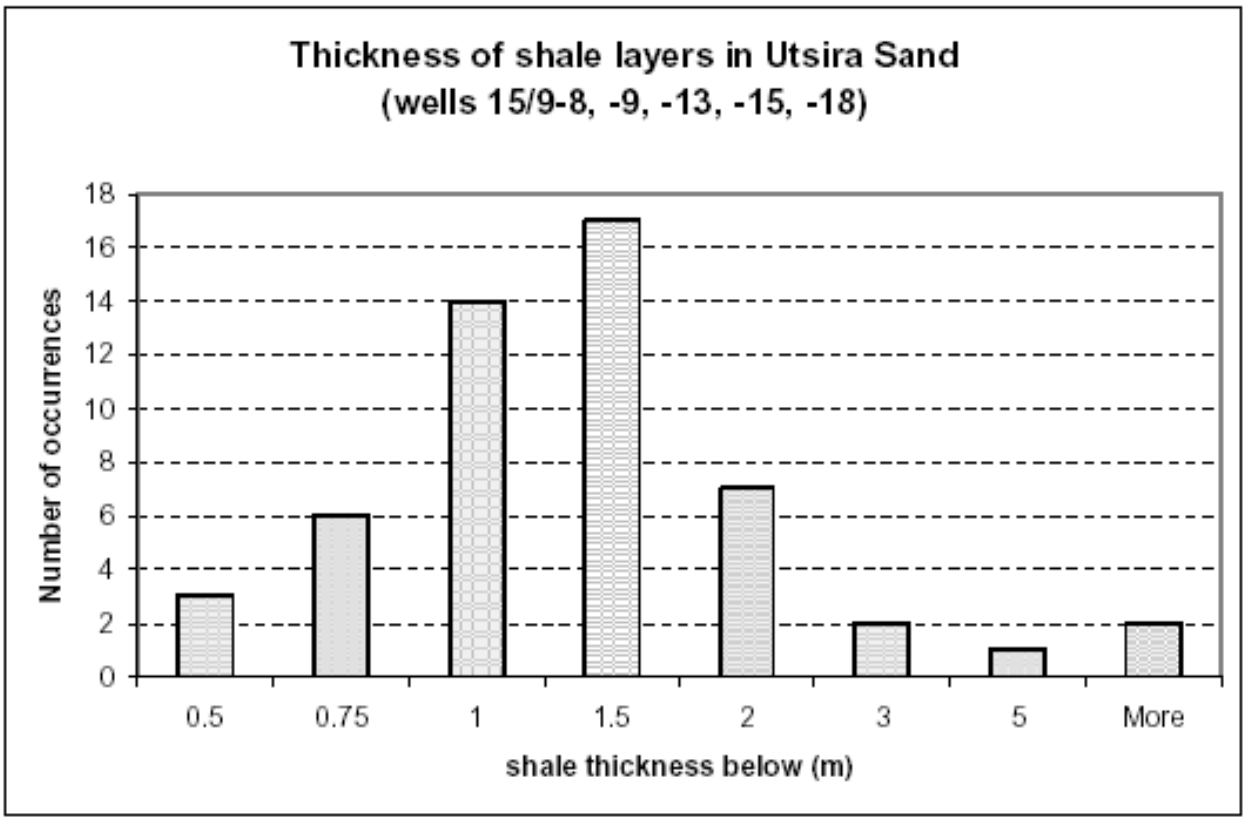


Figure 14. Thickness distribution of intra-reservoir shales, based on detailed interpretation of well log data from wells around Sleipner.

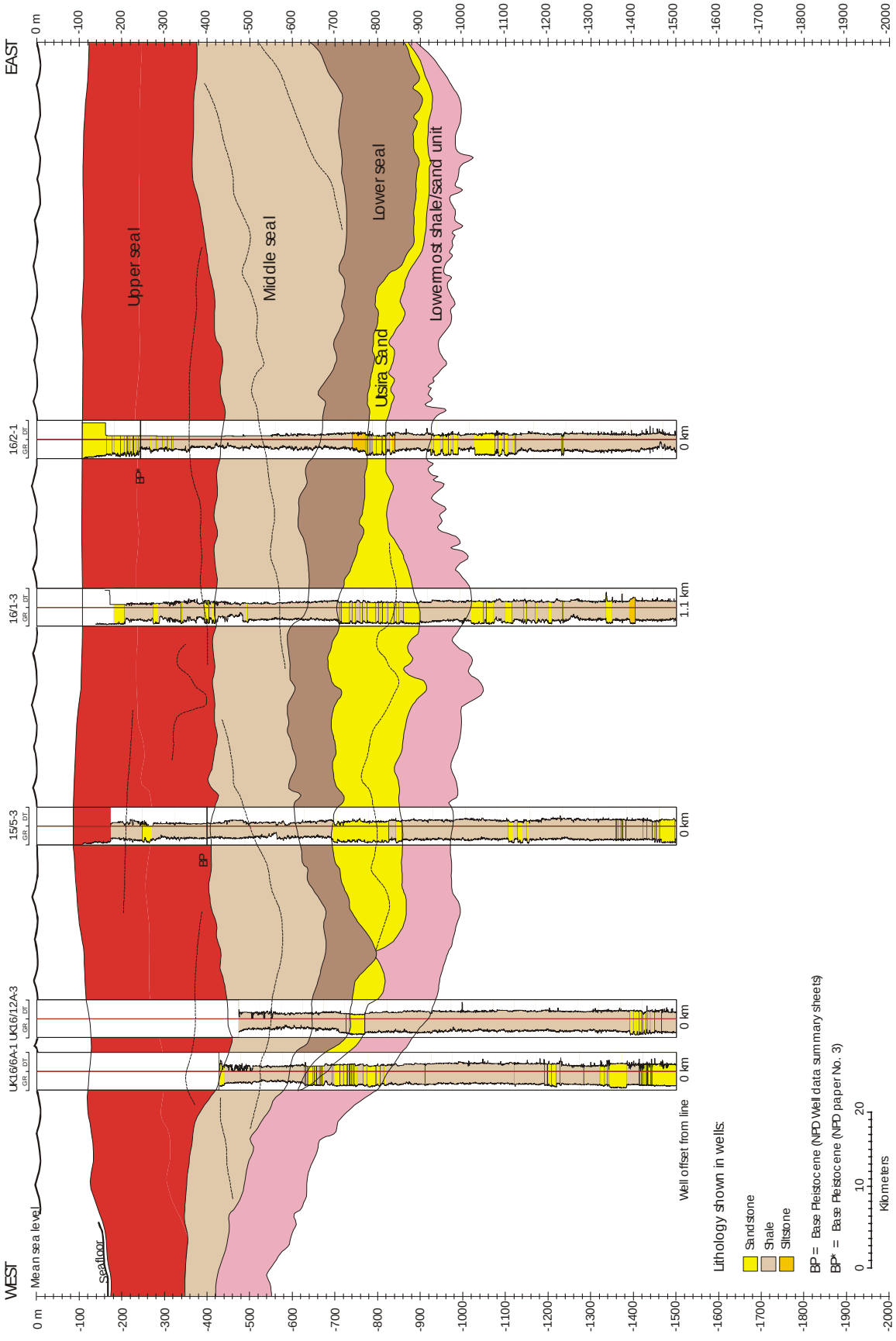


Figure 15. Interpreted geoseismic and well correlation section across the southern Utsira depocentre, showing the Utsira Sand and the main units of the caprock succession (see Figure 1 for location).

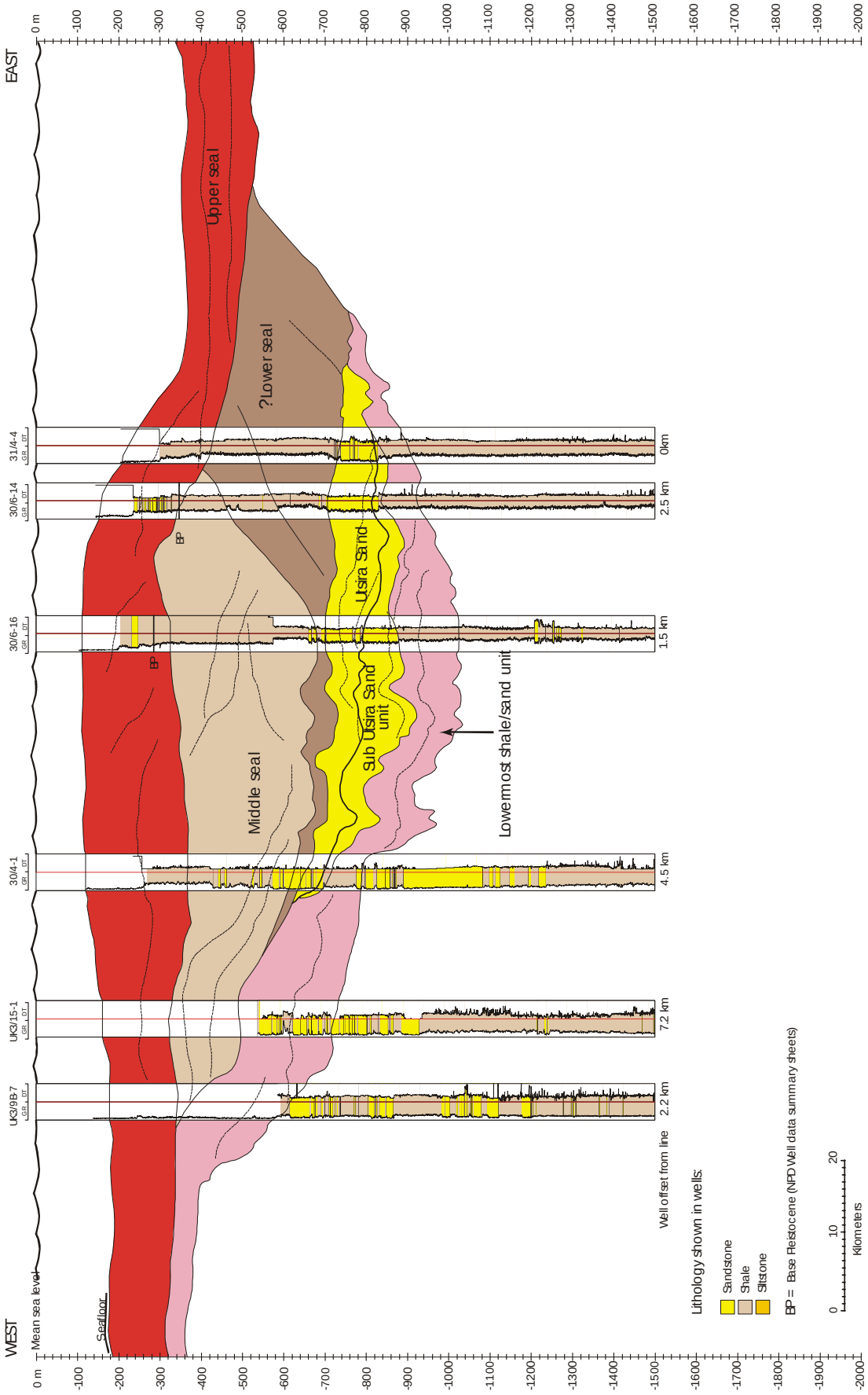


Figure 16. Interpreted geoseismic and well correlation section across the northern Utsira depocentre, showing the Utsira Sand and the main units of the caprock succession (see Figure 1 for location).

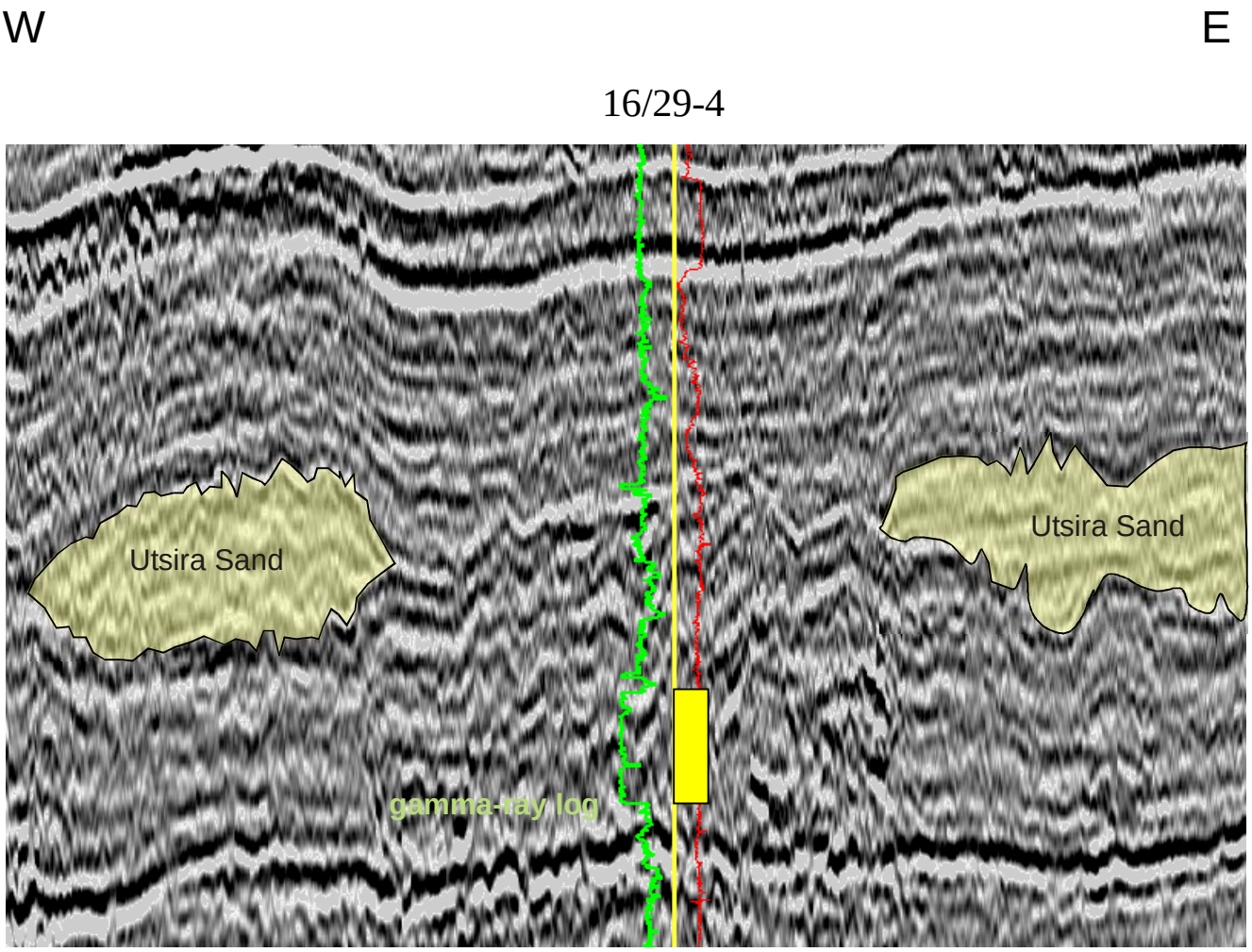
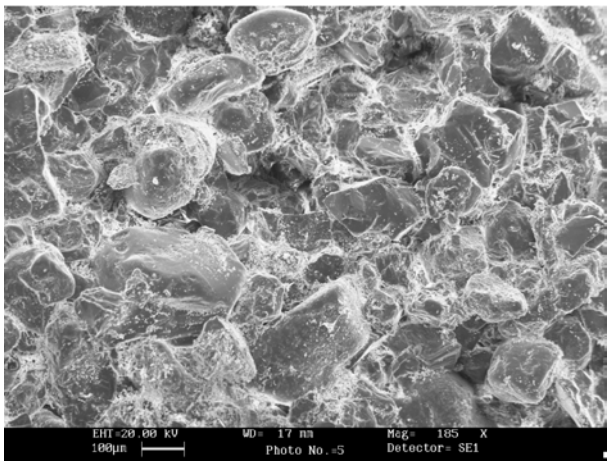
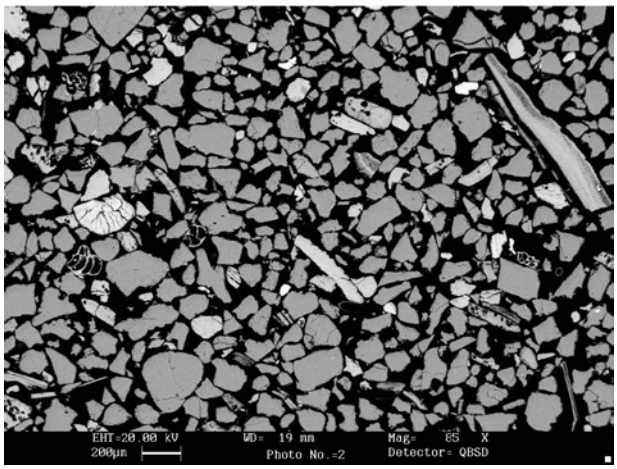


Figure 17. Complex distribution of the Utsira Sand at the western margin of the southern depocentre. Note the sand unit in UK well 16/29-4, formerly incorrectly identified as the Utsira Sand.

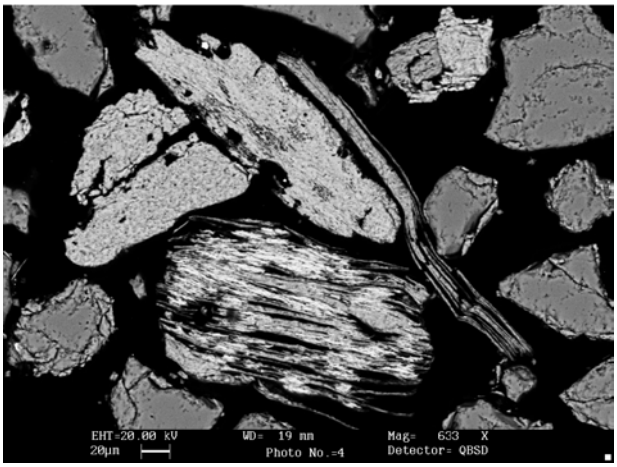
a



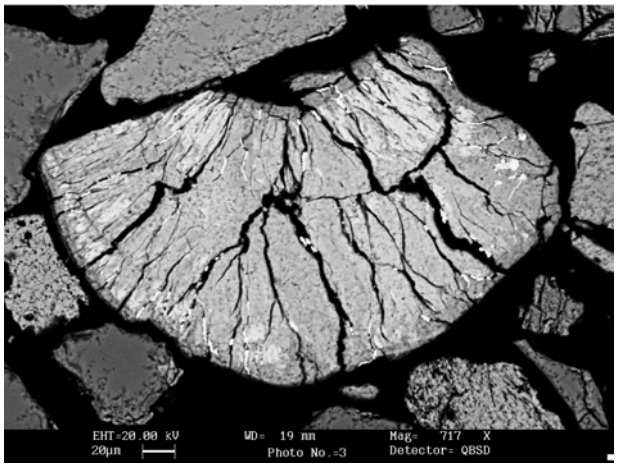
b



c



d



e

Figure 18. a) Photograph of 1m part of the Utsira Sand core from Norwegian well 15/9-A-23. b) Moderately well-sorted, subrounded to subangular, fine to medium-grained Utsira Sand c) Utsira Sand with calcareous shell and foraminifera fragments d) Typical examples of altered biotite (bottom) and muscovite flakes e) Typical example of rare glauconite grain, partially replaced by collophanic material and pyrite in cracks.

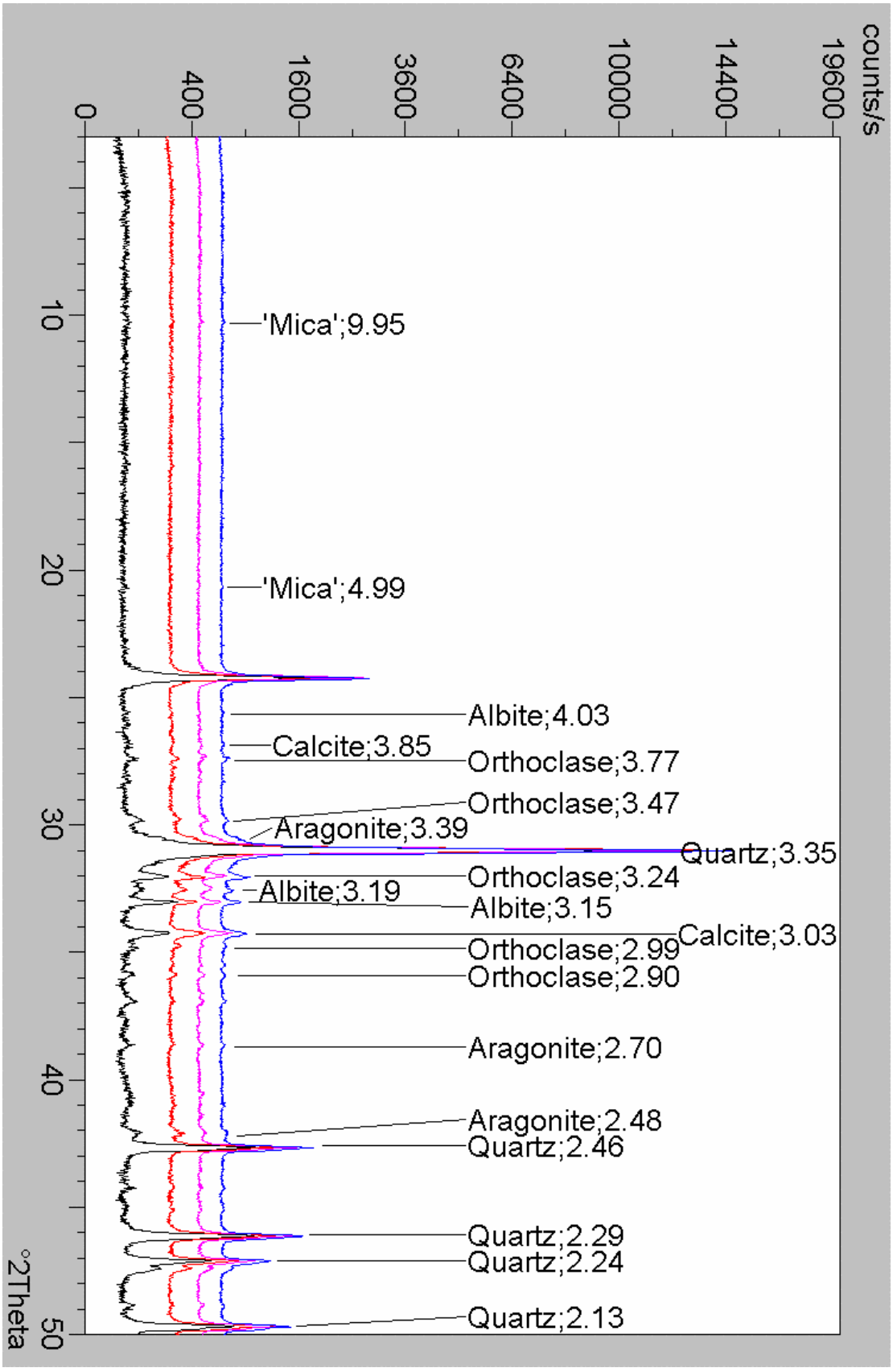


Figure 19. Whole-rock X-ray diffraction traces for samples E641A (black trace), E642 (red trace), E643 (magenta trace) and E644 (blue trace) showing major peak assignations and d spacings. Co-Kα radiation.

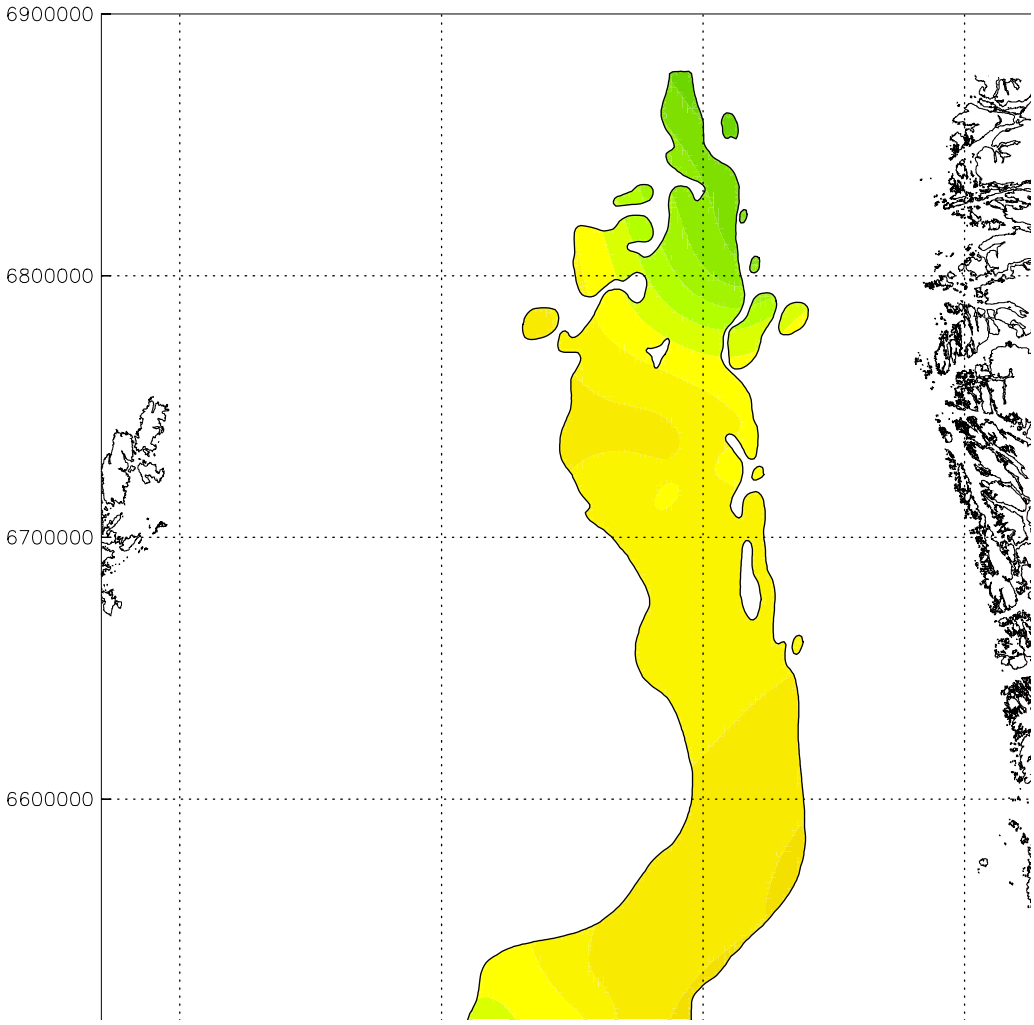


Figure 20. Porosity of the Utsira Sand, computed from well logs (dot denotes CO_2 injection point).

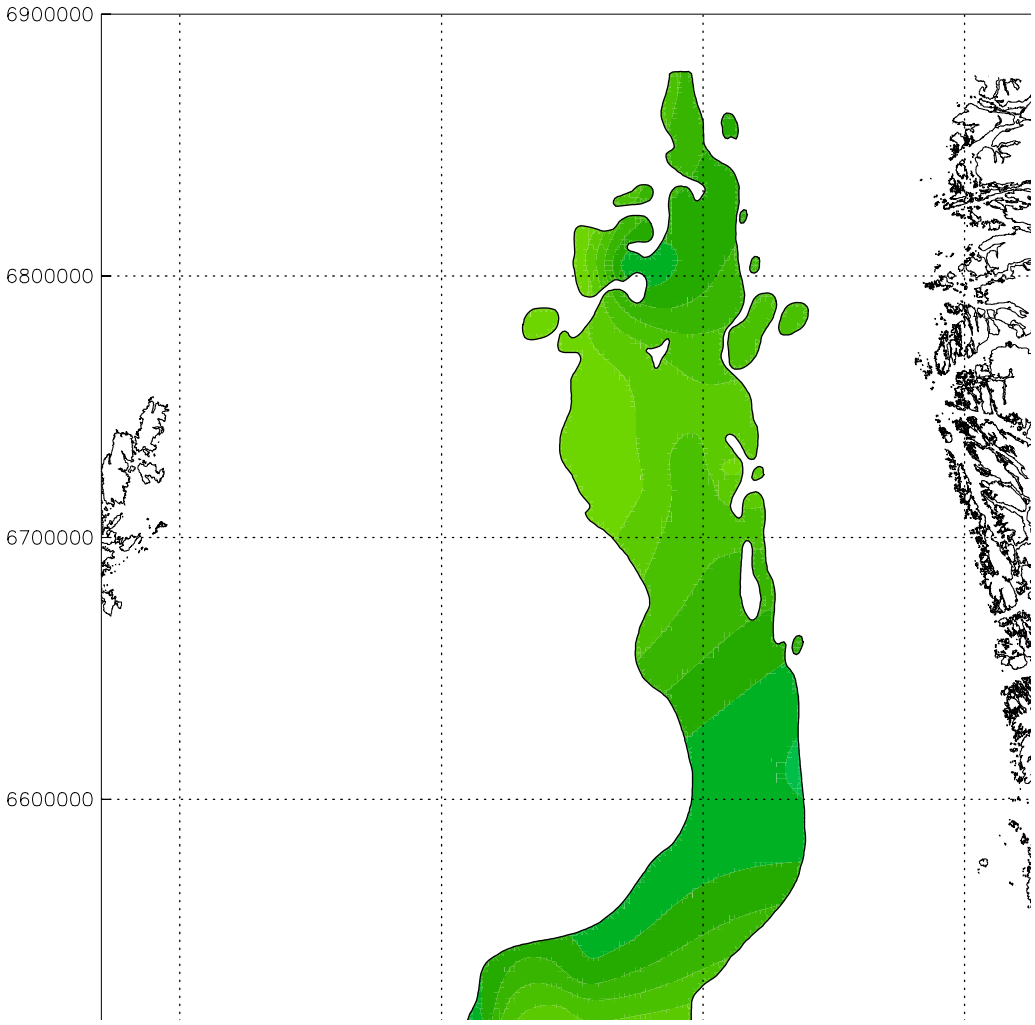
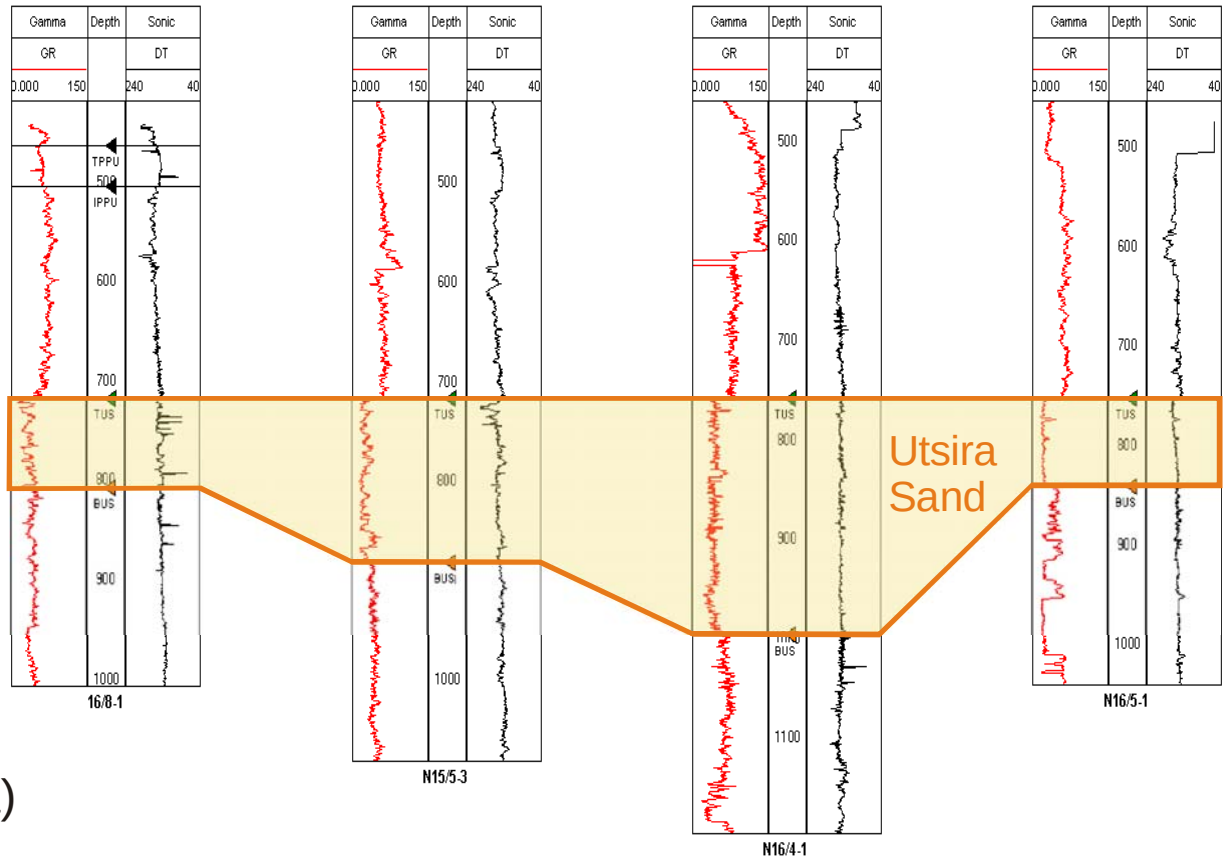
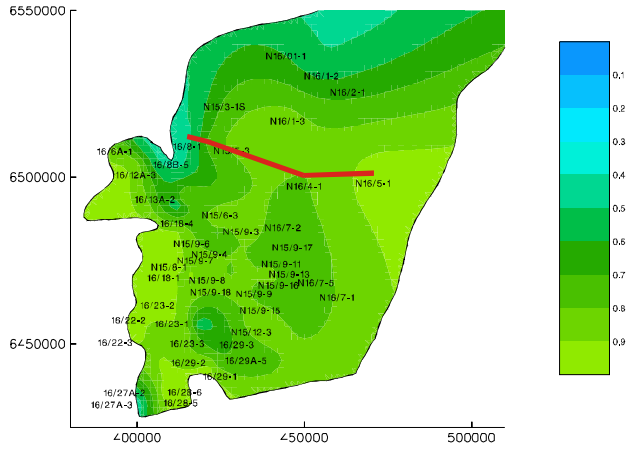


Figure 21. Percentage clean sand in the Utsira Sand, computed from well logs (dot denotes CO_2 injection point).



a)



b)

Figure 22. a) Log correlation cross-section across the southern Utsira depocentre, showing the lateral variation in shale content (percentage clean sand). b) Section location with map of percentage clean sand in southern depocentre.

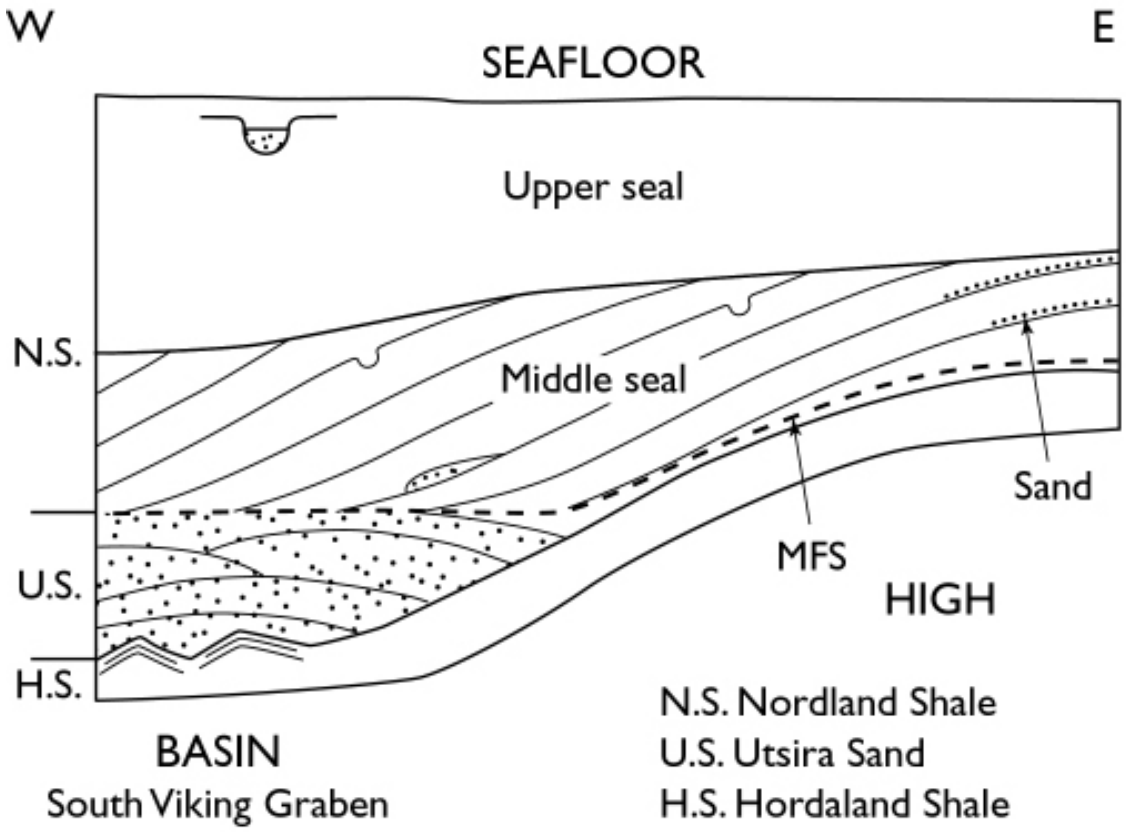
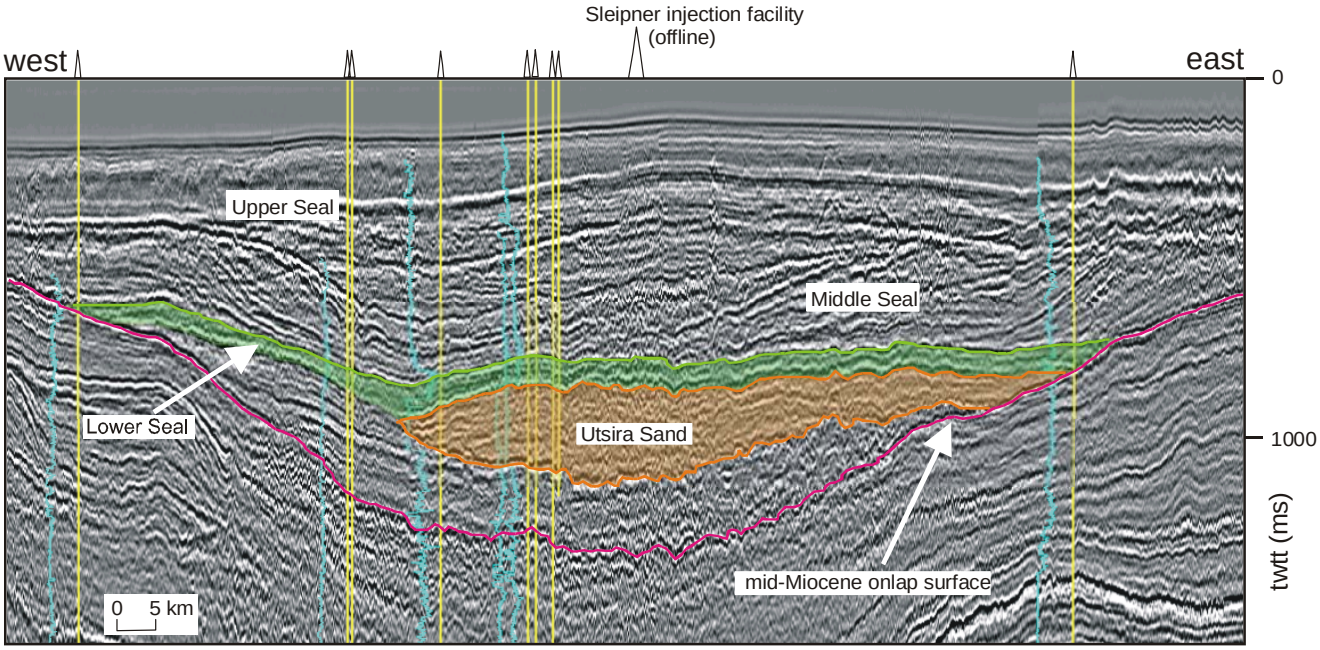
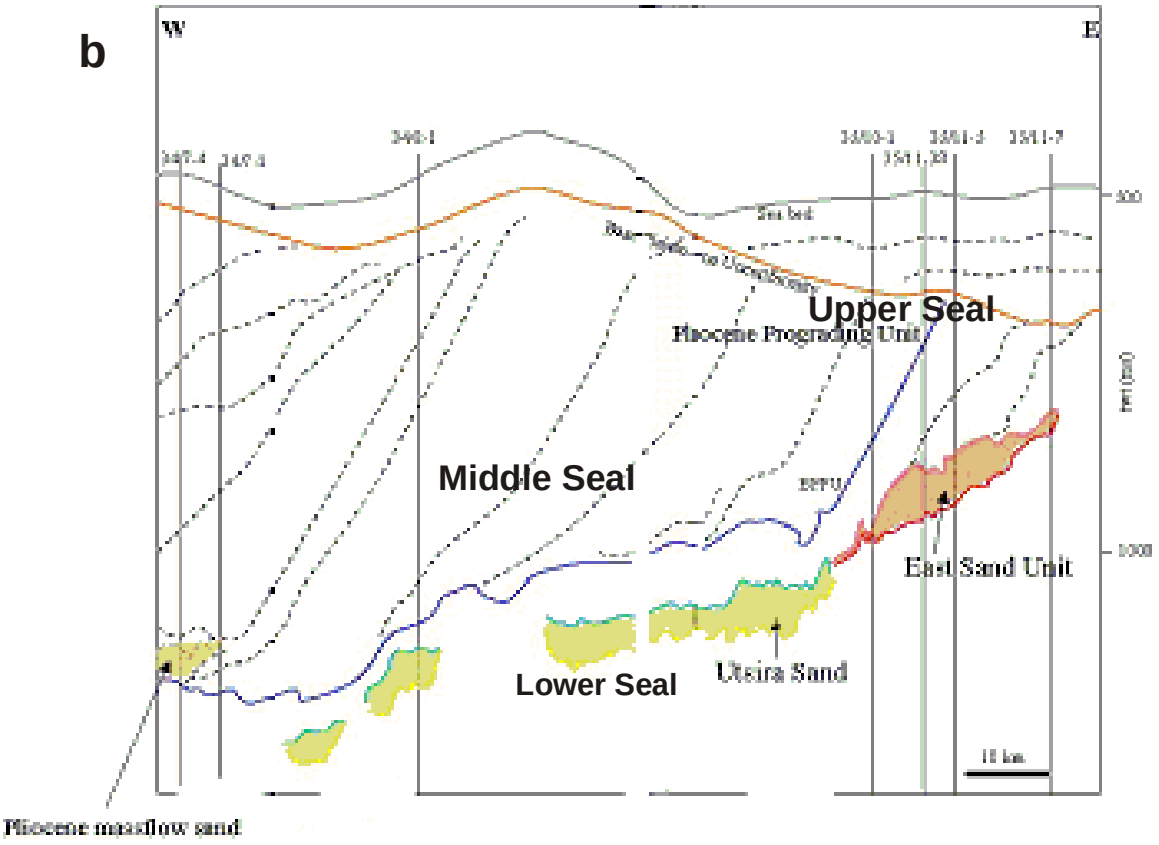


Figure 23. Schematic diagram of Pliocene prograding wedges and possible distribution of lithologies.



a



b

Figure 24. a) Seismic section across the southern Utsira depocentre showing the main caprock units. b) Interpreted geoseismic section across the northern Utsira depocentre shwing the main caprock units.

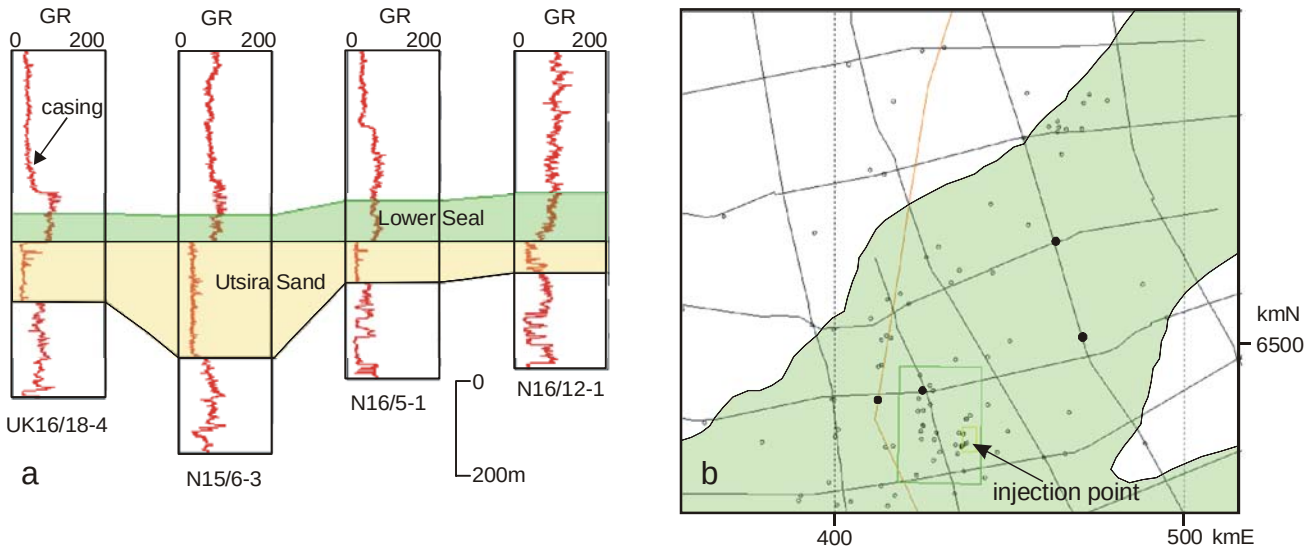


Figure 25. a) Log detail of the Lower Seal around Sleipner b) Extent of the Lower Seal above the southern Utsira depocentre. Larger rectangle denotes survey ST98M11, smaller rectangle denotes 1999 time-lapse survey.

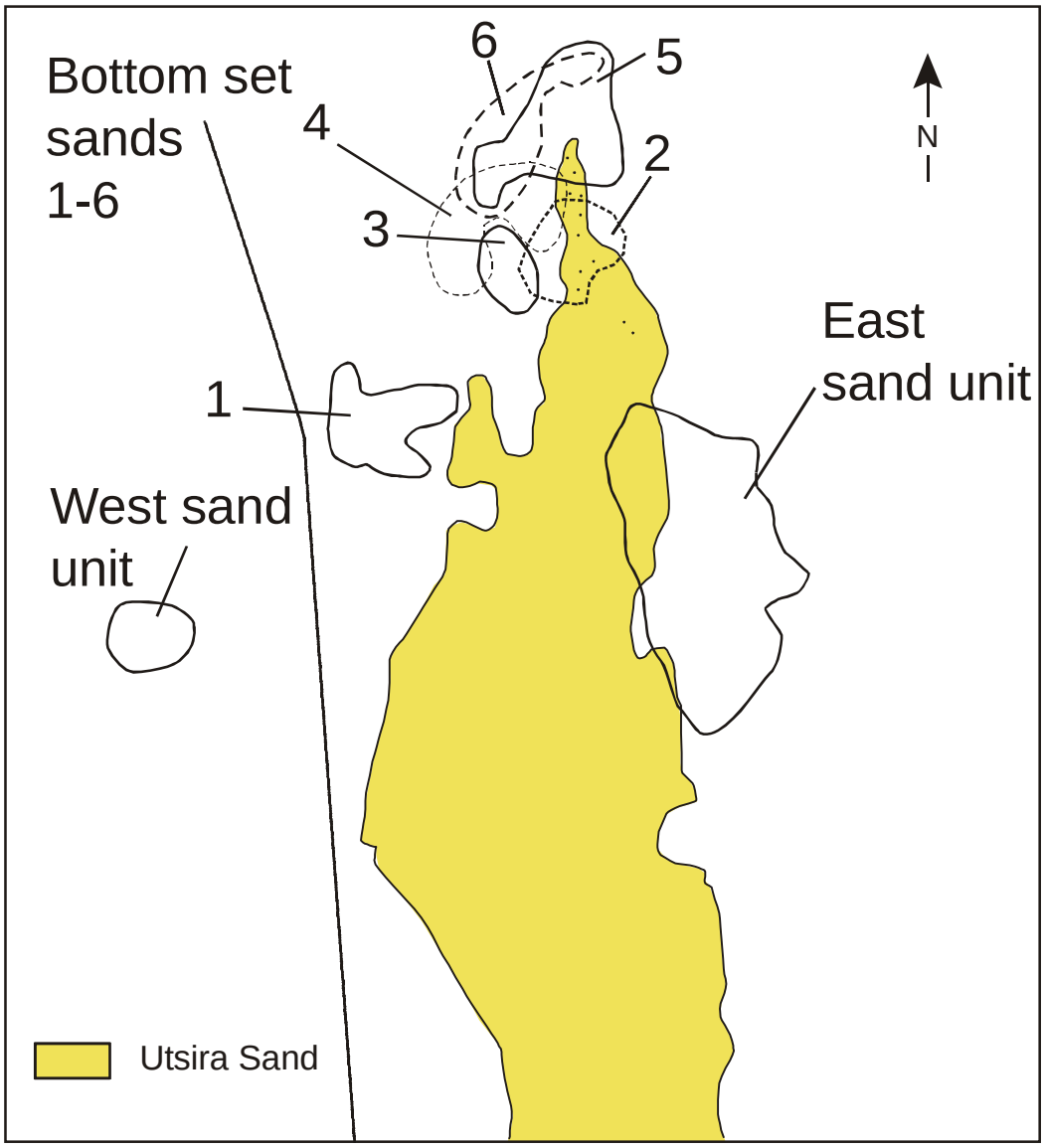
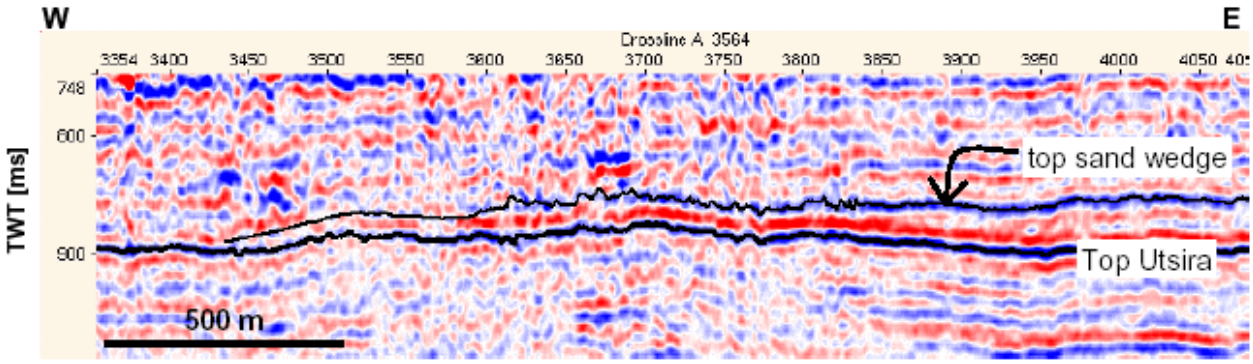


Figure 26. Distribution of minor sand units in the caprock succession.



a

b

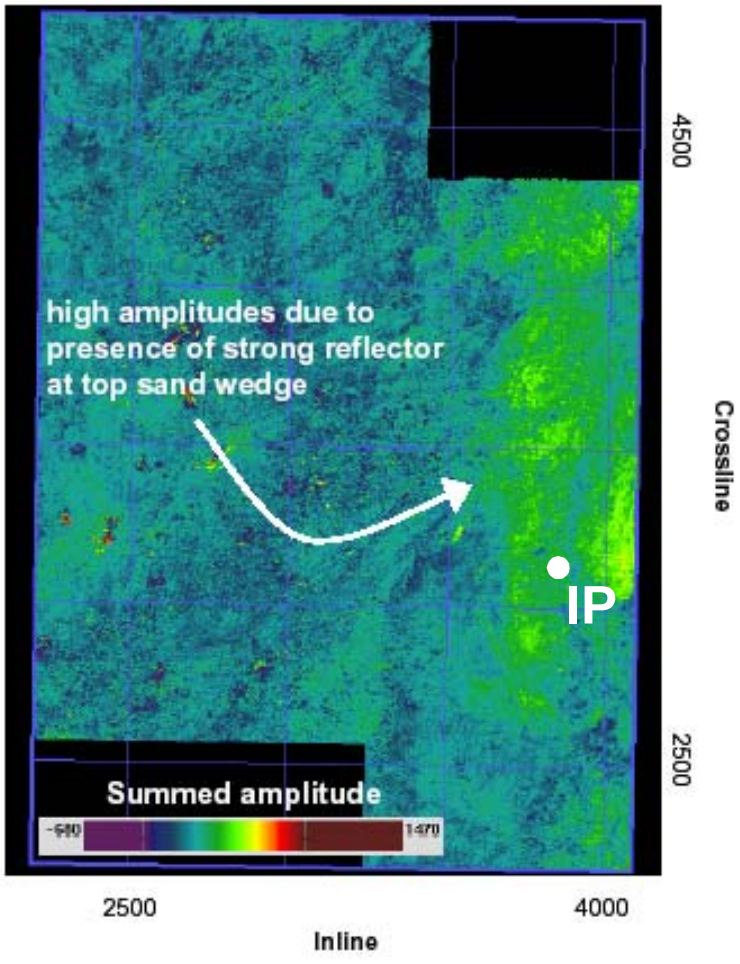


Figure 27. a) The Sand-wedge on seismic b) Approximate extent of Sand-wedge picked out by high amplitudes c) Thickness map (metres) of the Sand-wedge based on seismic mapping and well data.

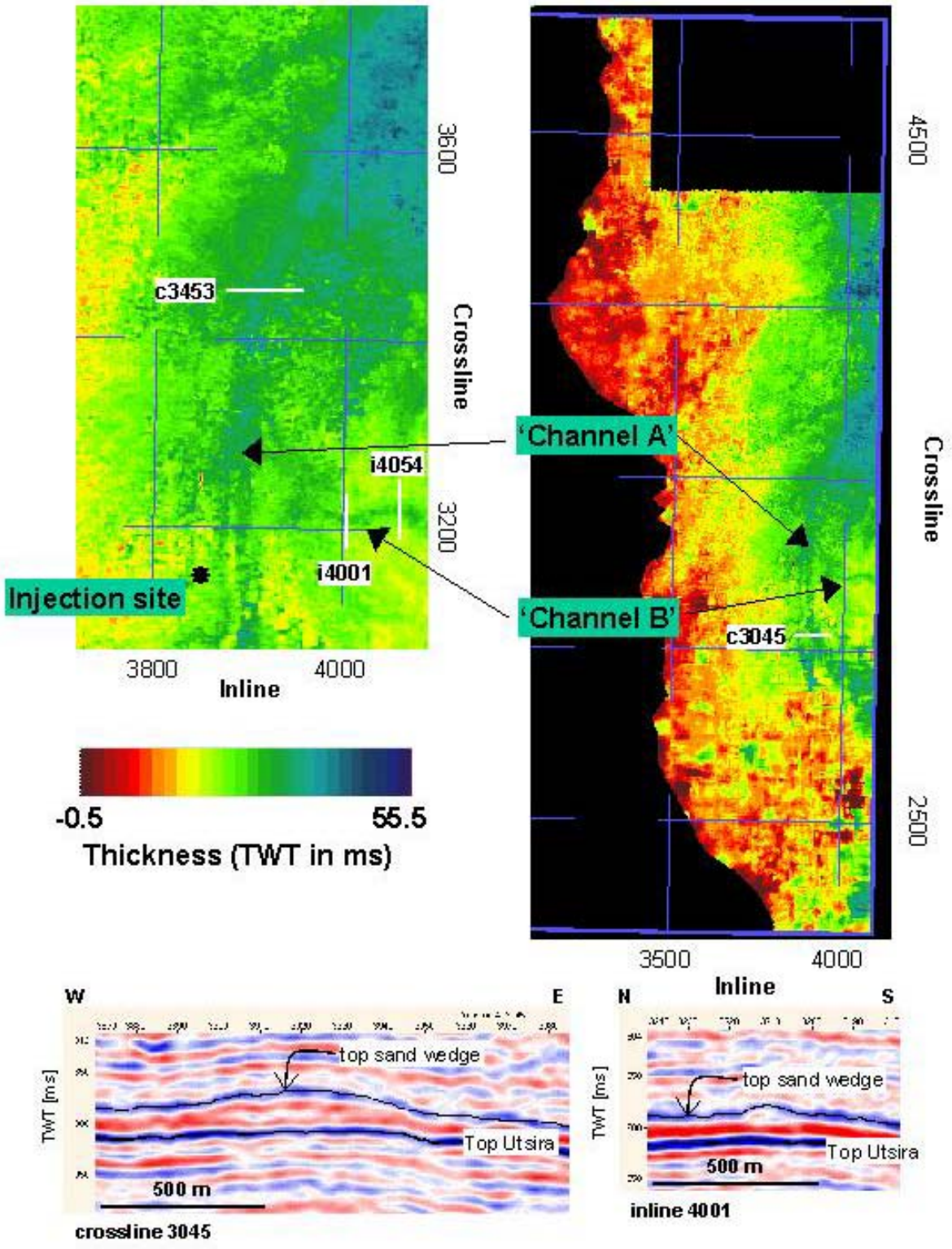


Figure 28. Thickness maps of the Sand-wedge (upper), reveal curved linear features interpreted as channels, also visible on individual seismic lines (lower).

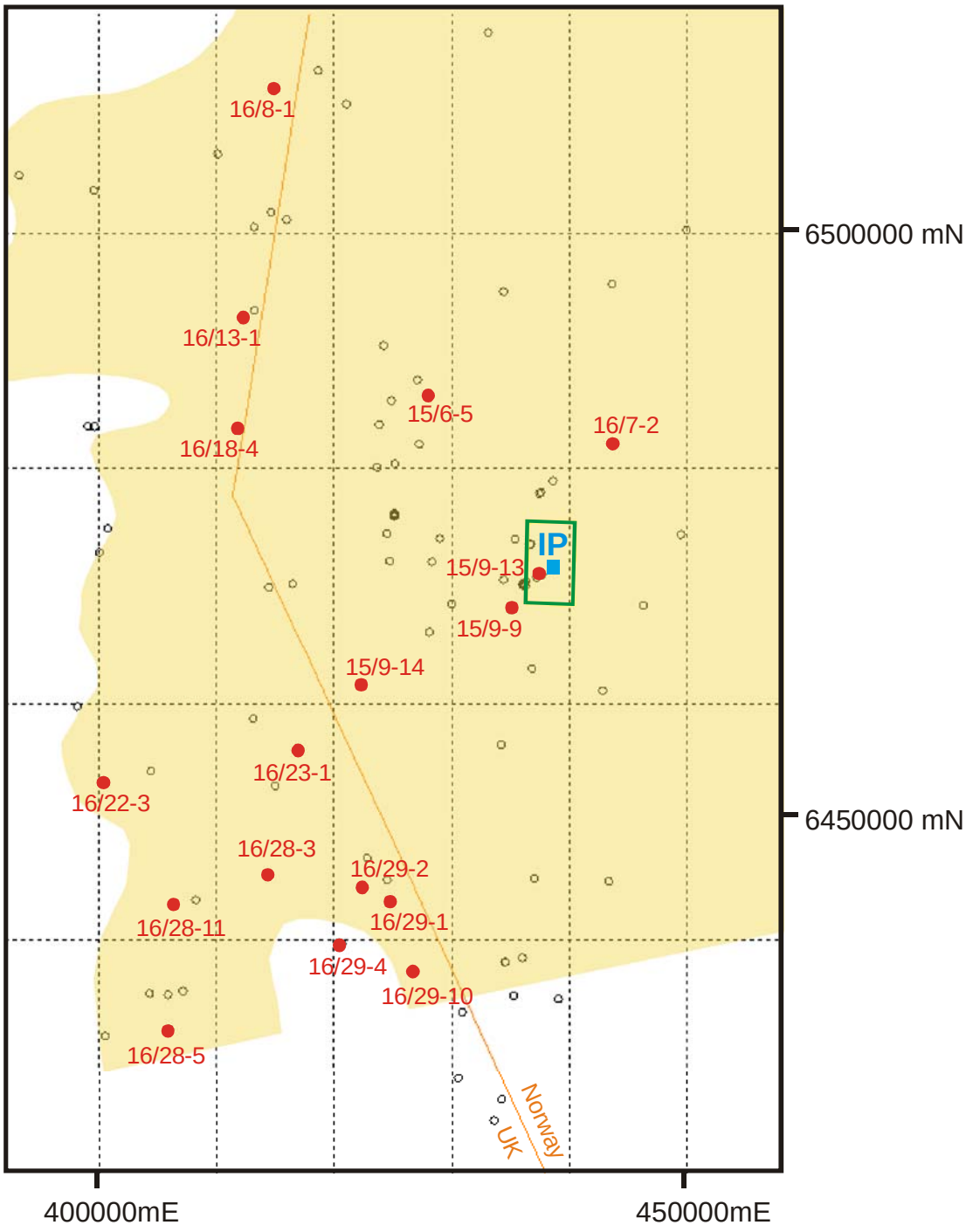


Figure 29. Wells with caprock cuttings samples. IP denotes CO_2 injection point. Green rectangle shows area of 1999 time-lapse seismic survey. Shaded area denotes extent of Utsira Sand.

Figure 30. Typical examples of caprock cuttings a) shale fragments from Norwegian well 15/9-9, 615 m depth b) grey shale fragments from Norwegian well 15/9-14, 855 m depth.

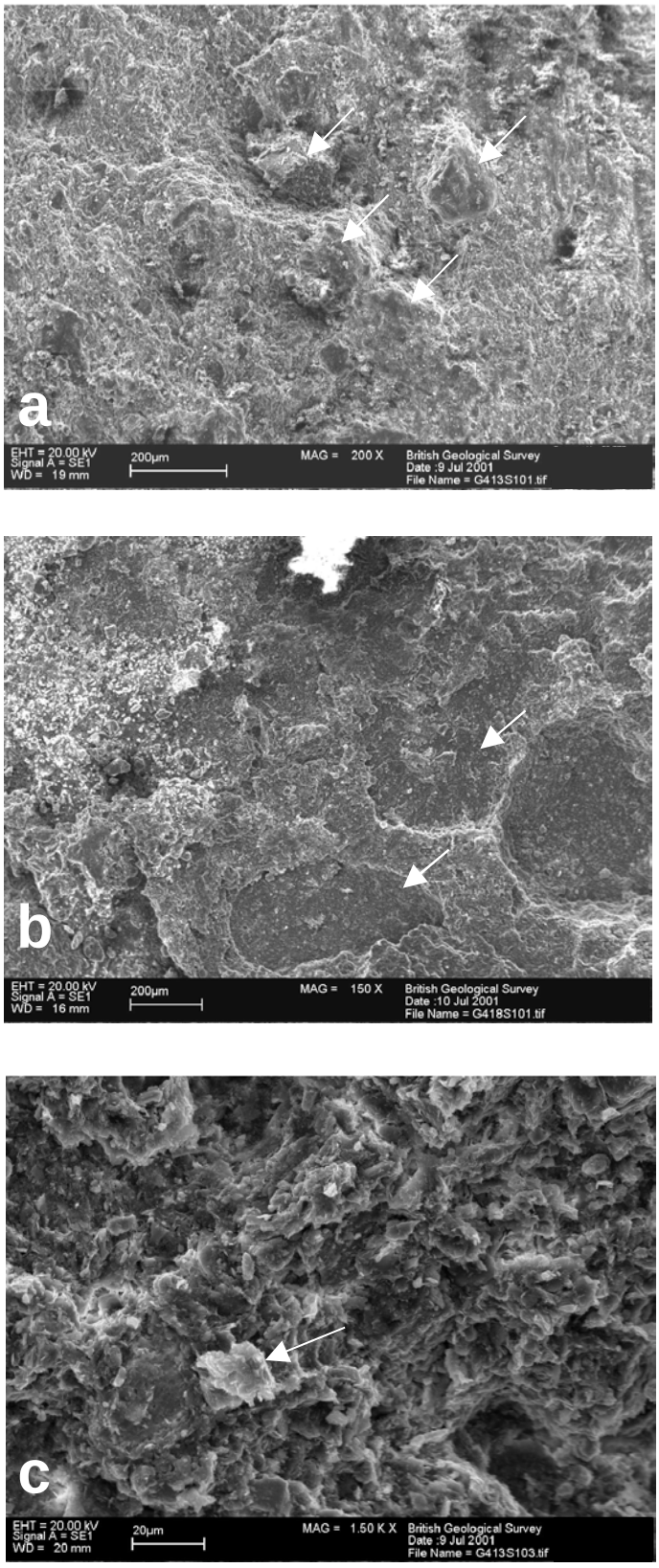


Figure 31. SEM images of caprock cuttings material from wells in the UK sector a) Massive mudrock with several rounded fine-grained quartz grains, UK well16/29-1, 907 m depth b) Massive mudrock with large (up to 0.5 mm) voids (arrowed) where sand grains have been plucked out, UK well 16/28-3, 990 m depth c) High magnification detail of massive mudrock, showing tightly packed rather randomly-oriented clay particles. Note presence of clay mineral particles (arrowed), up to 20 µm in diameter, UK well 16/29-1, 907m depth.

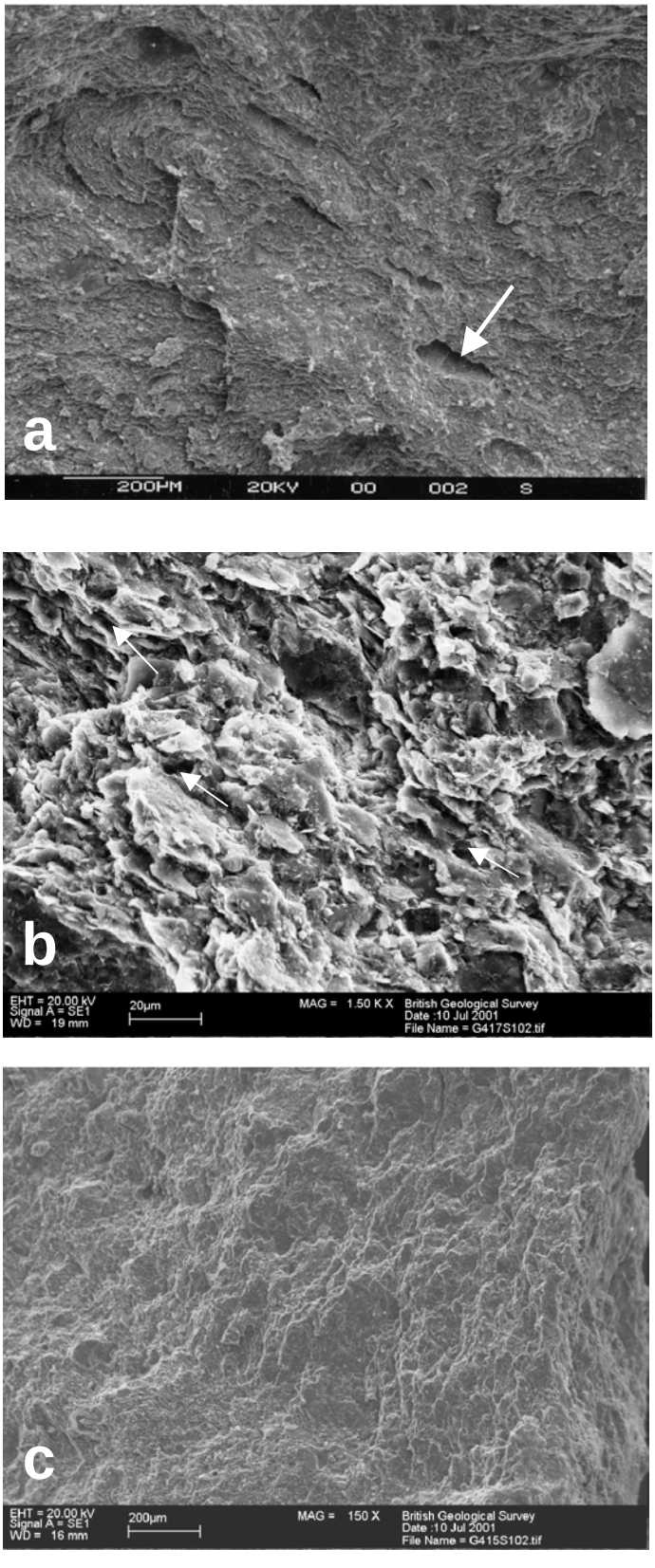


Figure 32. a)Laminated mudrock with holes where fine sand grade grains have been plucked out, UK well 16/29-4, 1055 m depth b) High magnification detail of laminated mudrock showing tightly packed platelets with preferred orientation. Micropores (arrowed) are a few microns in diamater and poorly connected with each other, UK well 16/28-3, 970 m depth. c) Laminated mudrock, lamination defines terraced appearance of sample, UK well 16/29-1, 998 m.

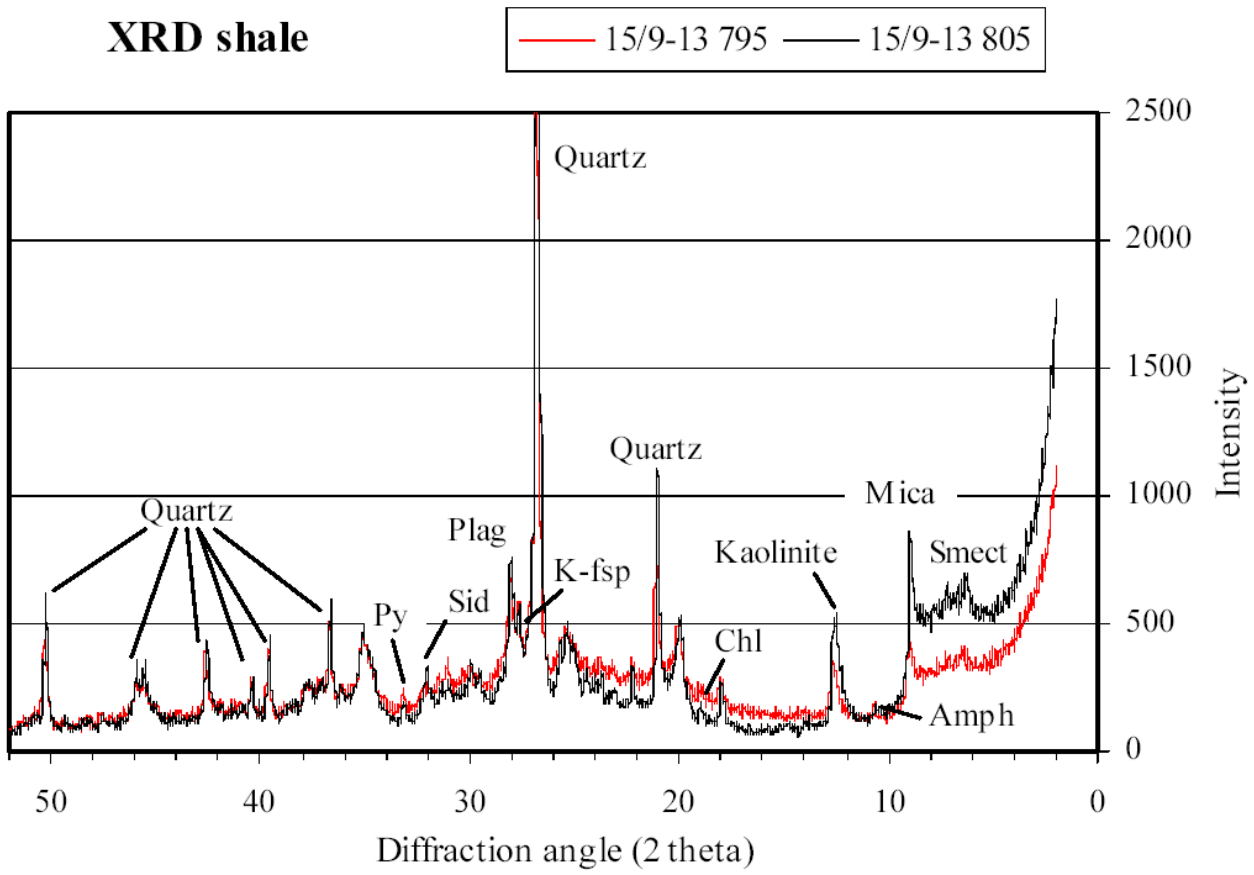
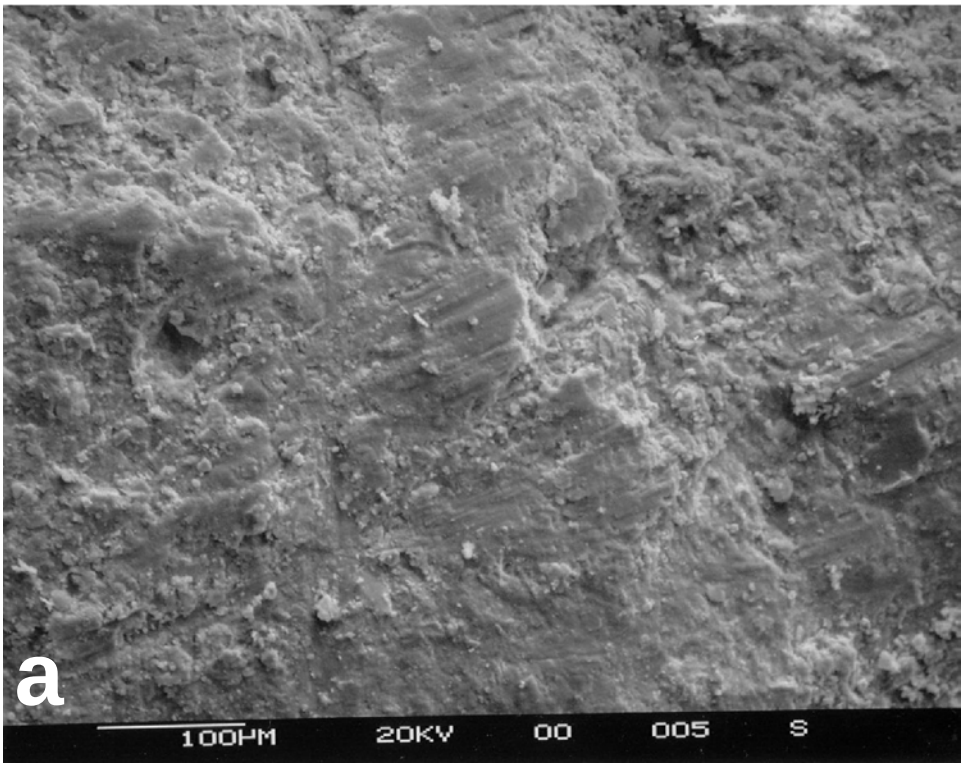


Figure 33. X-ray diffraction traces from two caprock samples from Norwegian well 15/9-13, 795 and 085 m depth.



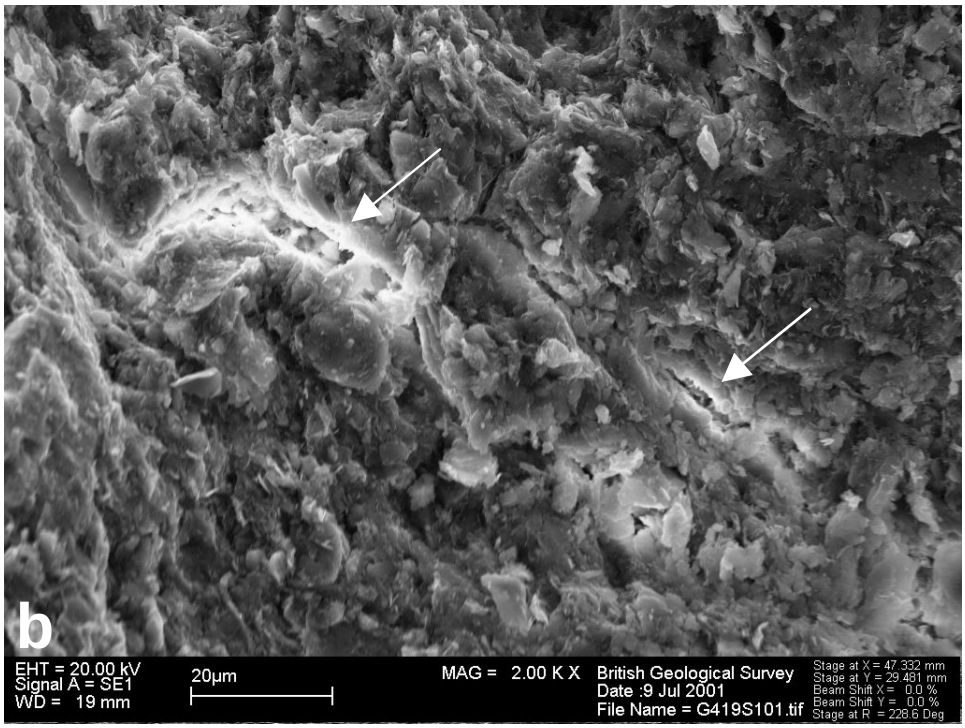


Figure 34. a) Mudrock with well-developed slickensides, UK well 16/28-5, 1100 m depth b) Mudrock with microfractures (arrowed), interpreted to result from sample shrinkage during drying out UK well 16/23-1 945 m depth.

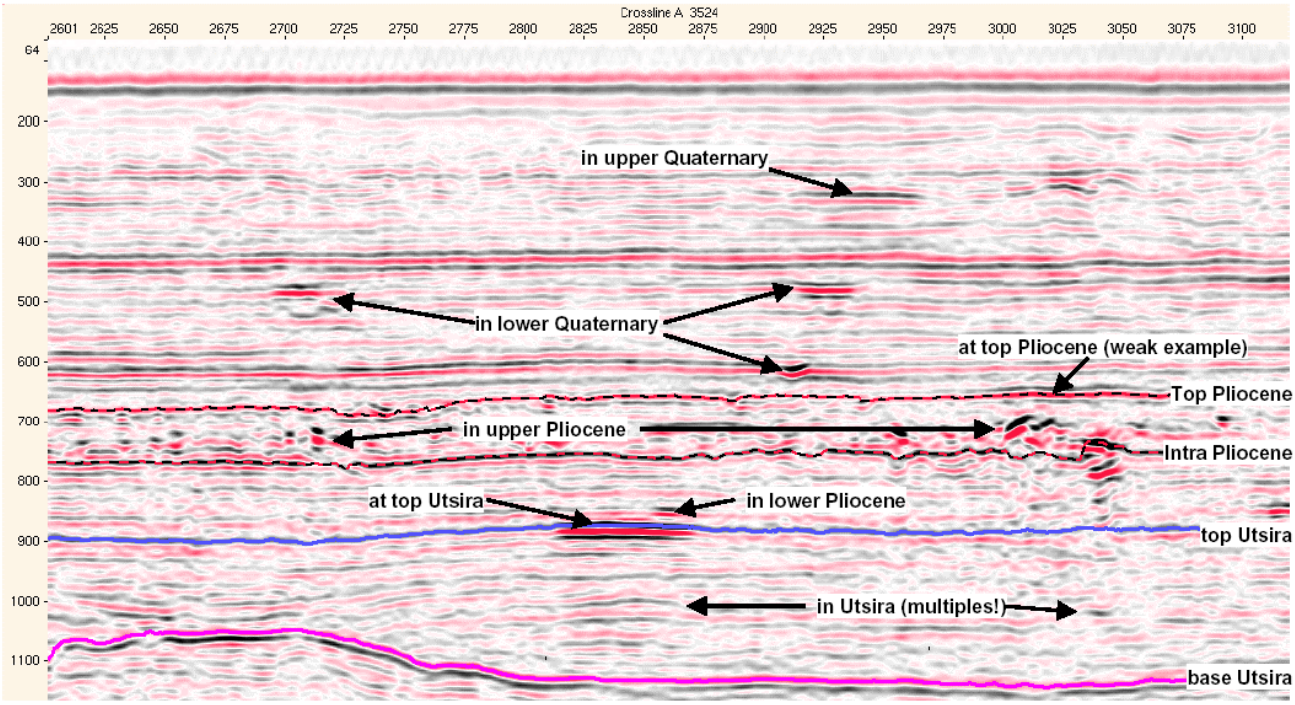


Figure 35. Seismic amplitude anomalies around and above the Utsira Sand

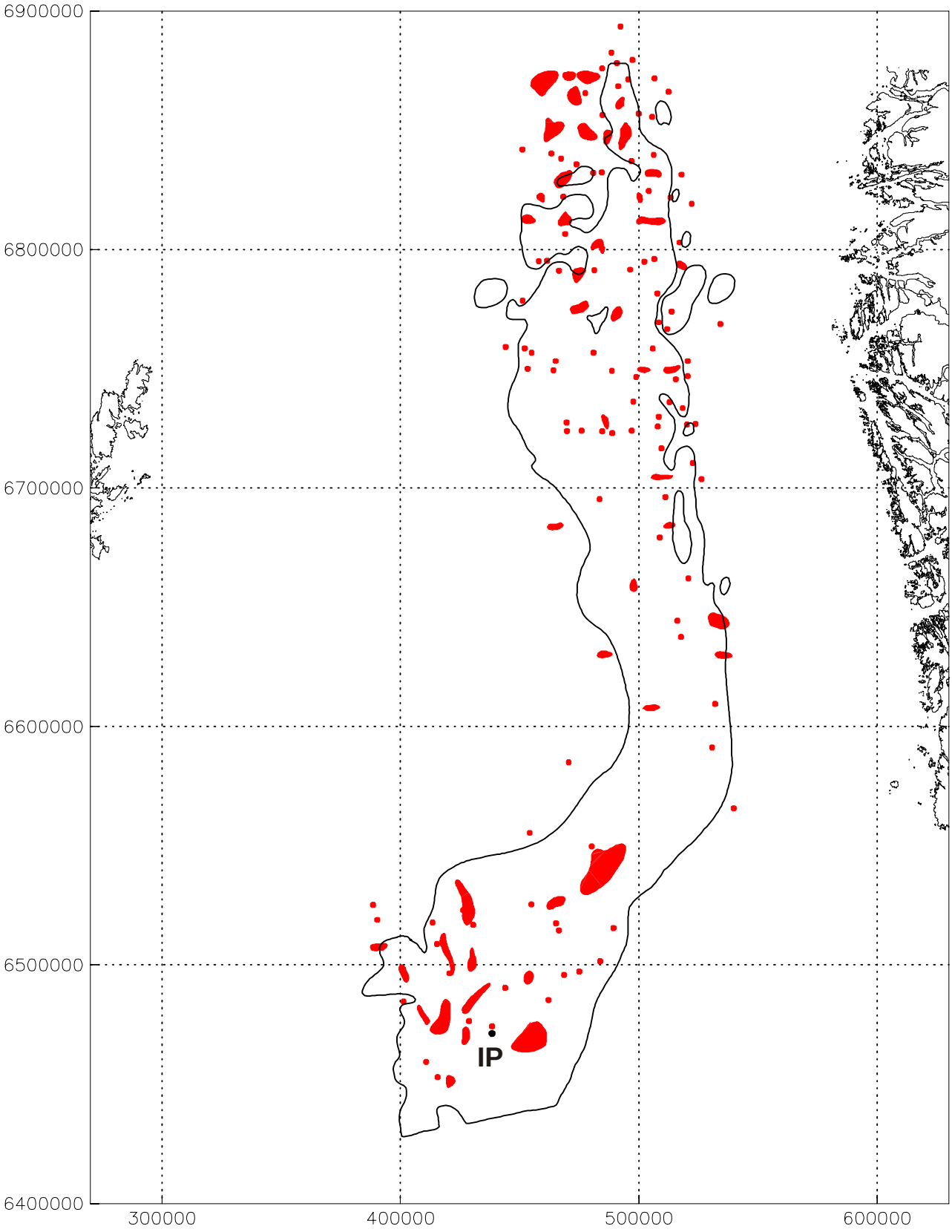


Figure 36. Regional distribution of seismic amplitude anomalies in the Lower Seal

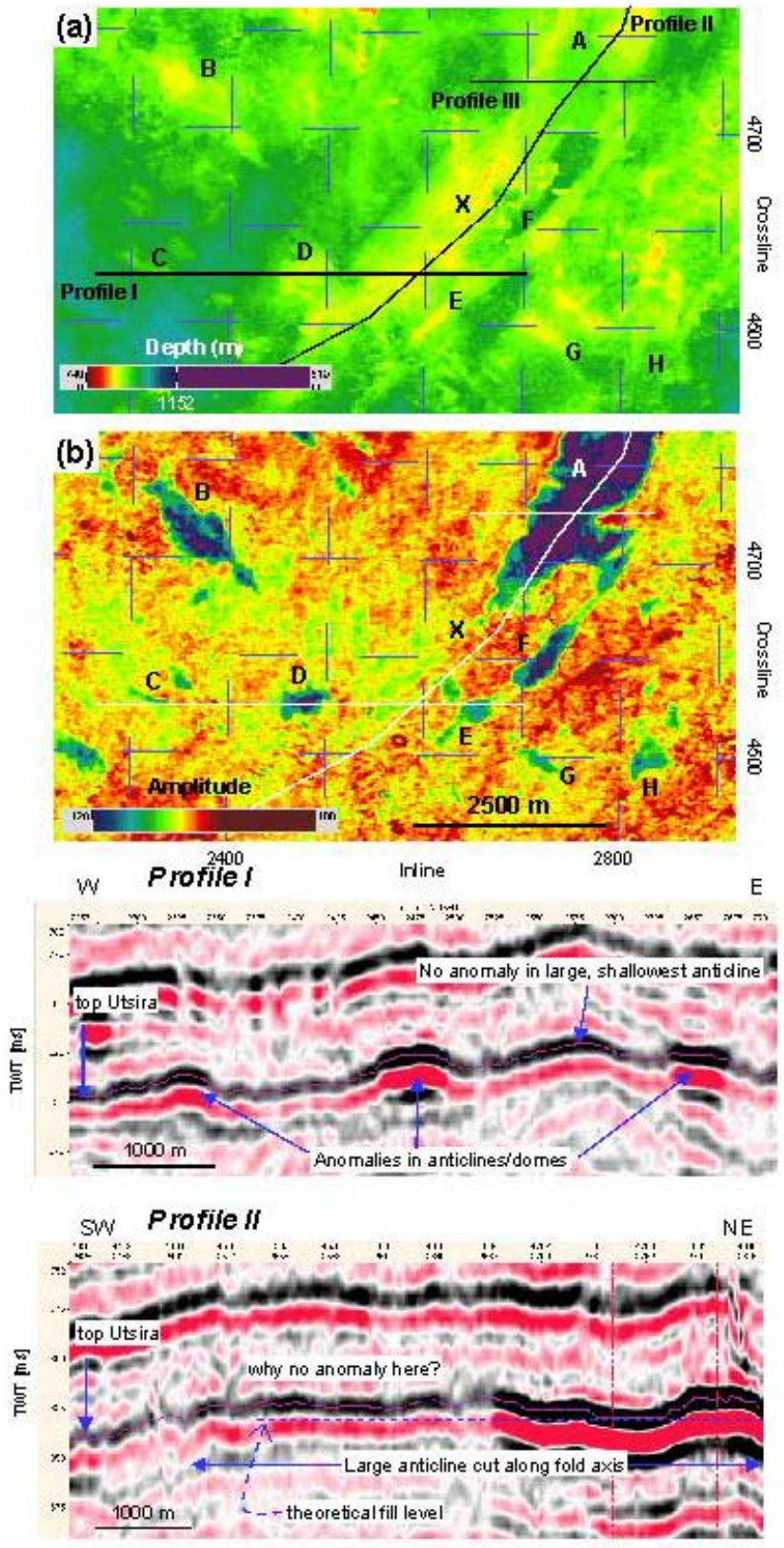


Figure 37. Seismic amplitude anomalies at the top of the Utsira Sand a) depth map b) seismic amplitude map, note prominent blue anomalies c) d) seismic sections through the anomalies, showing structural control of higher amplitudes.

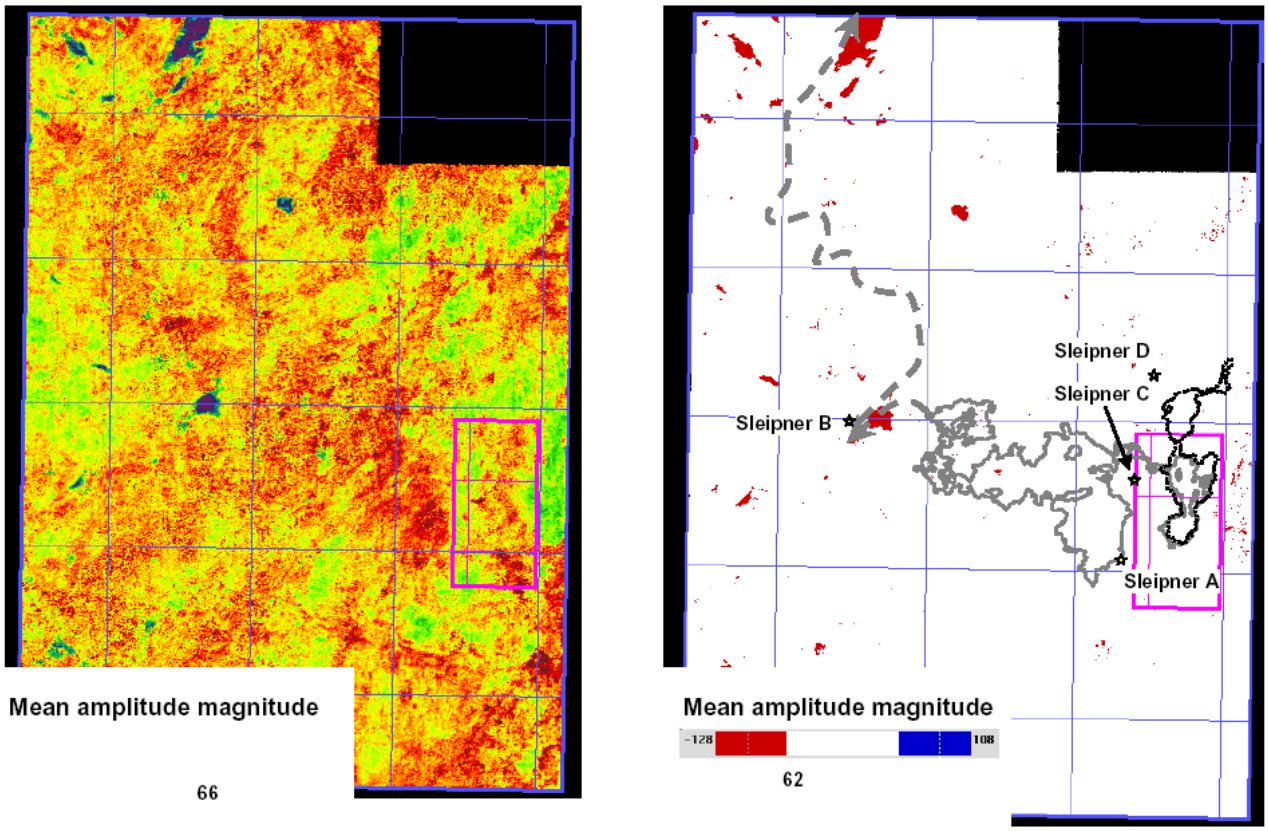


Figure 38. Survey ST98M11, seismic amplitude anomalies at top Utsira Sand

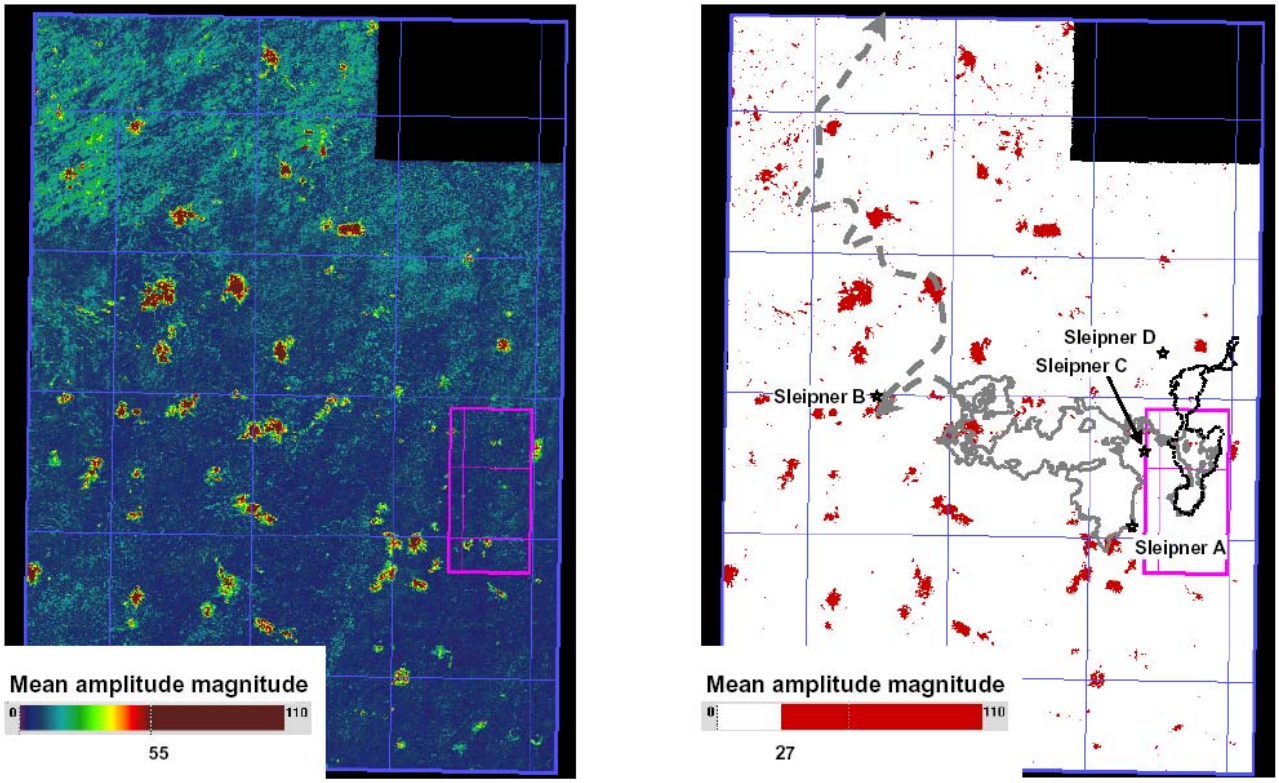


Figure 39. Survey ST98M11, seismic amplitude anomalies in the Lower Seal

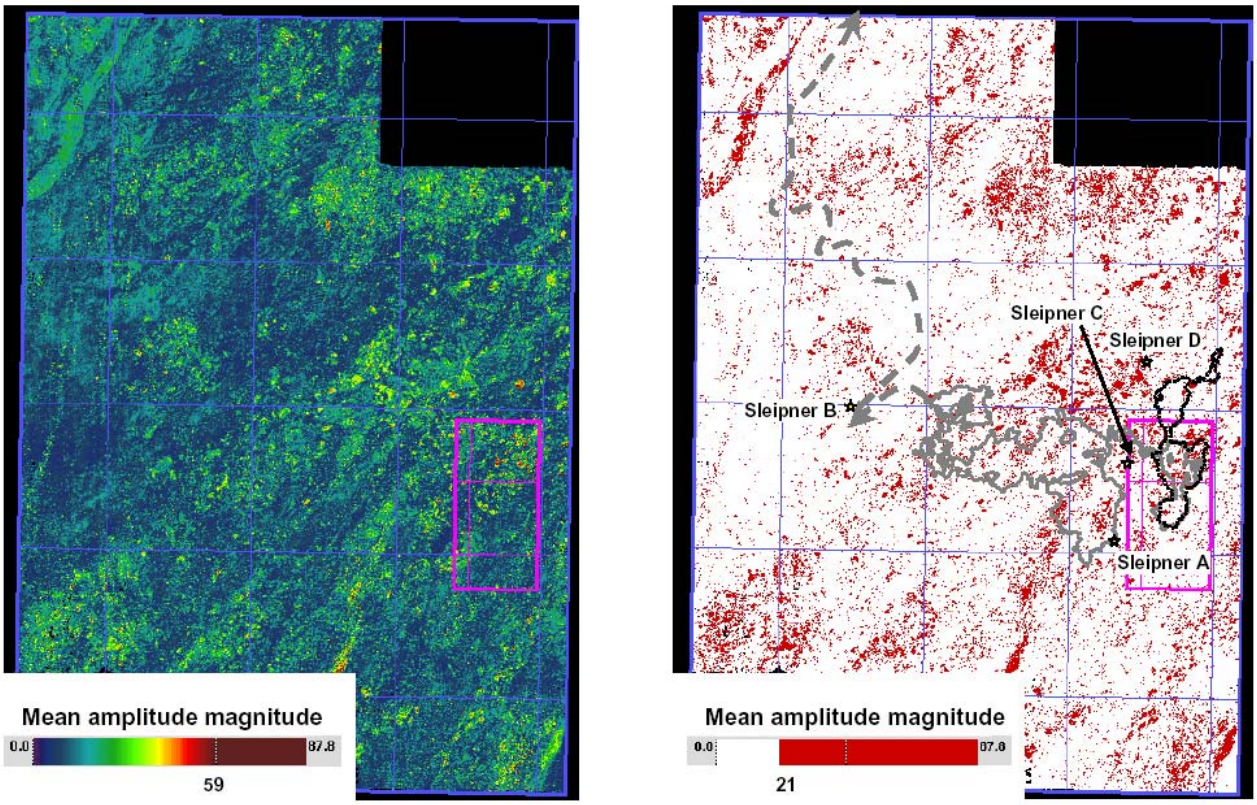


Figure 40. Survey ST98M11, seismic amplitude anomalies in the Middle Seal, note prominent NE-trending grain.

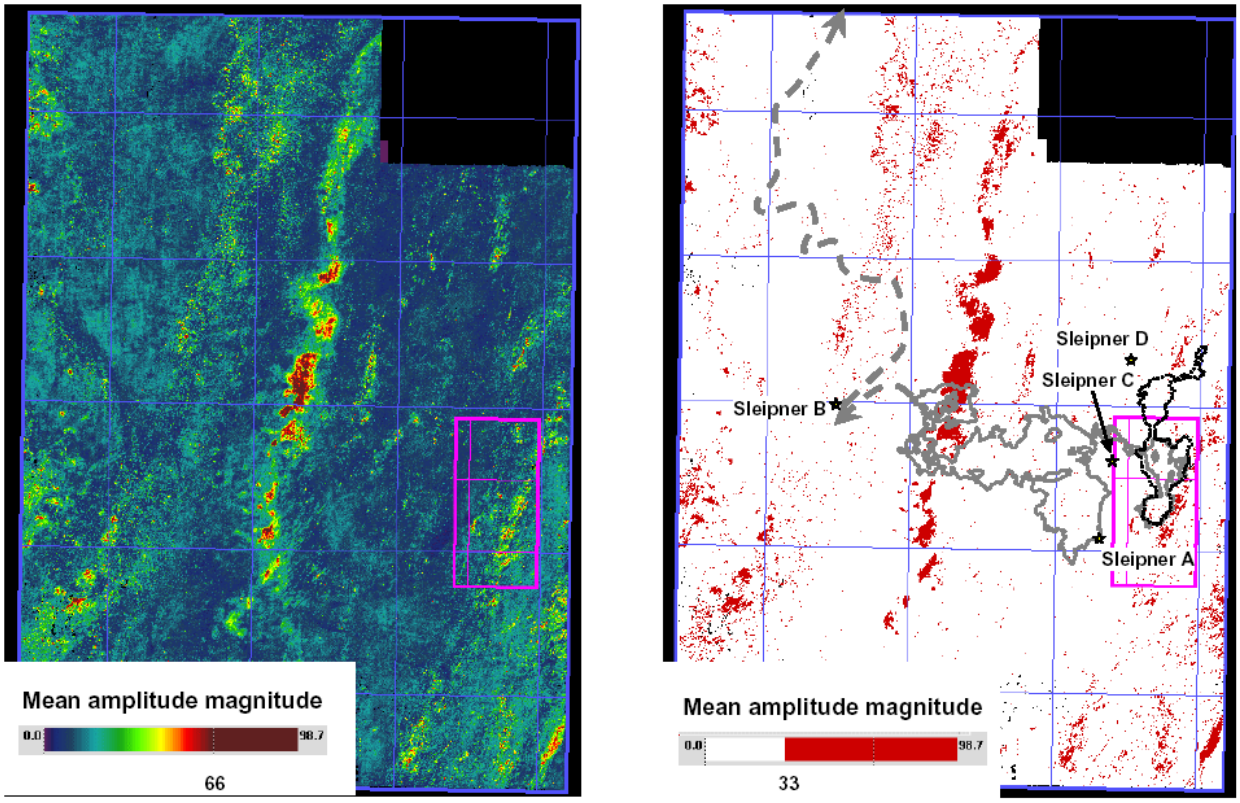


Figure 41. Survey ST98M11, seismic amplitude anomalies from the topmost Middle Seal, note the NNE linear trends, interpreted as channel features.

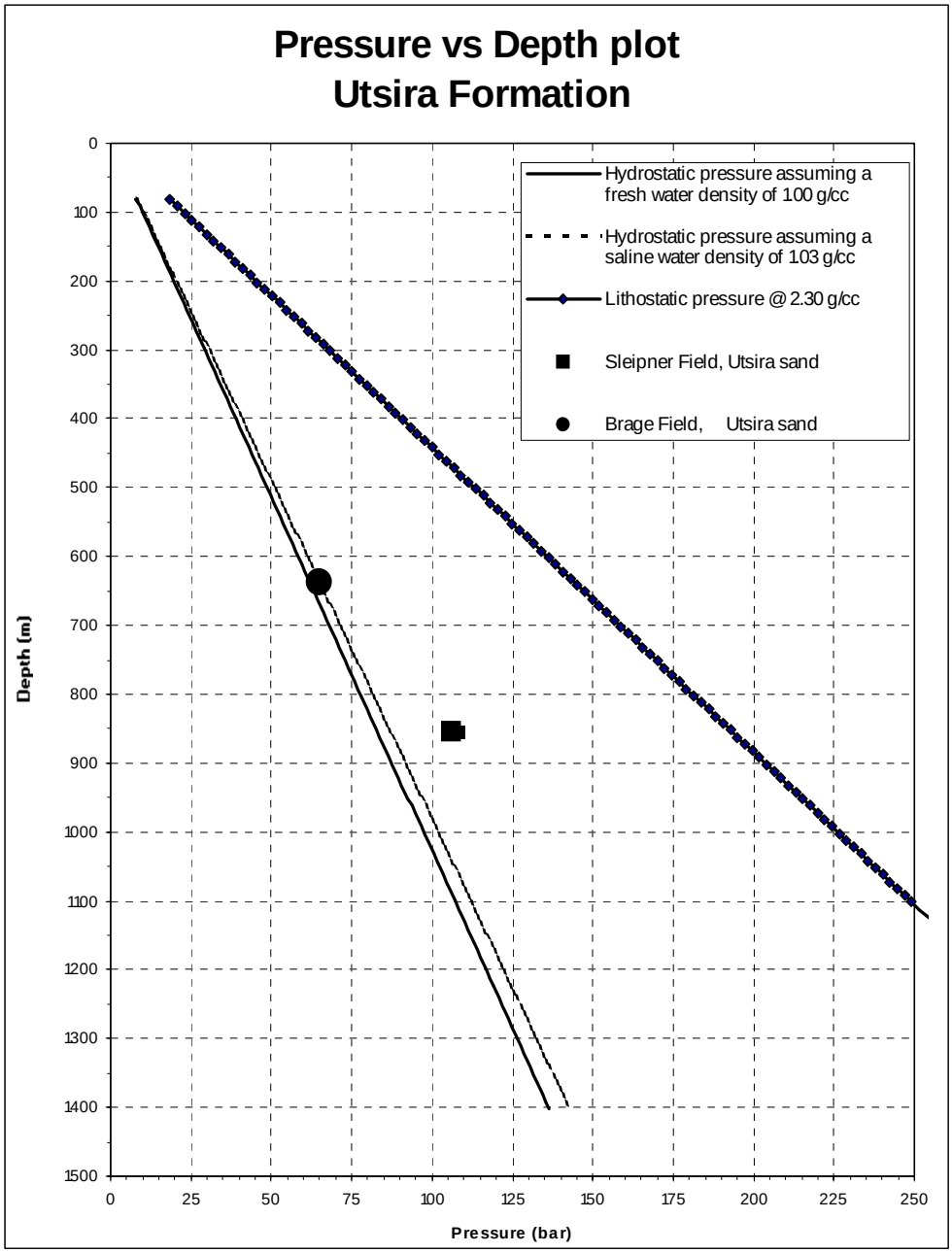


Figure 42. Formation pressure data from the Utsira Sand

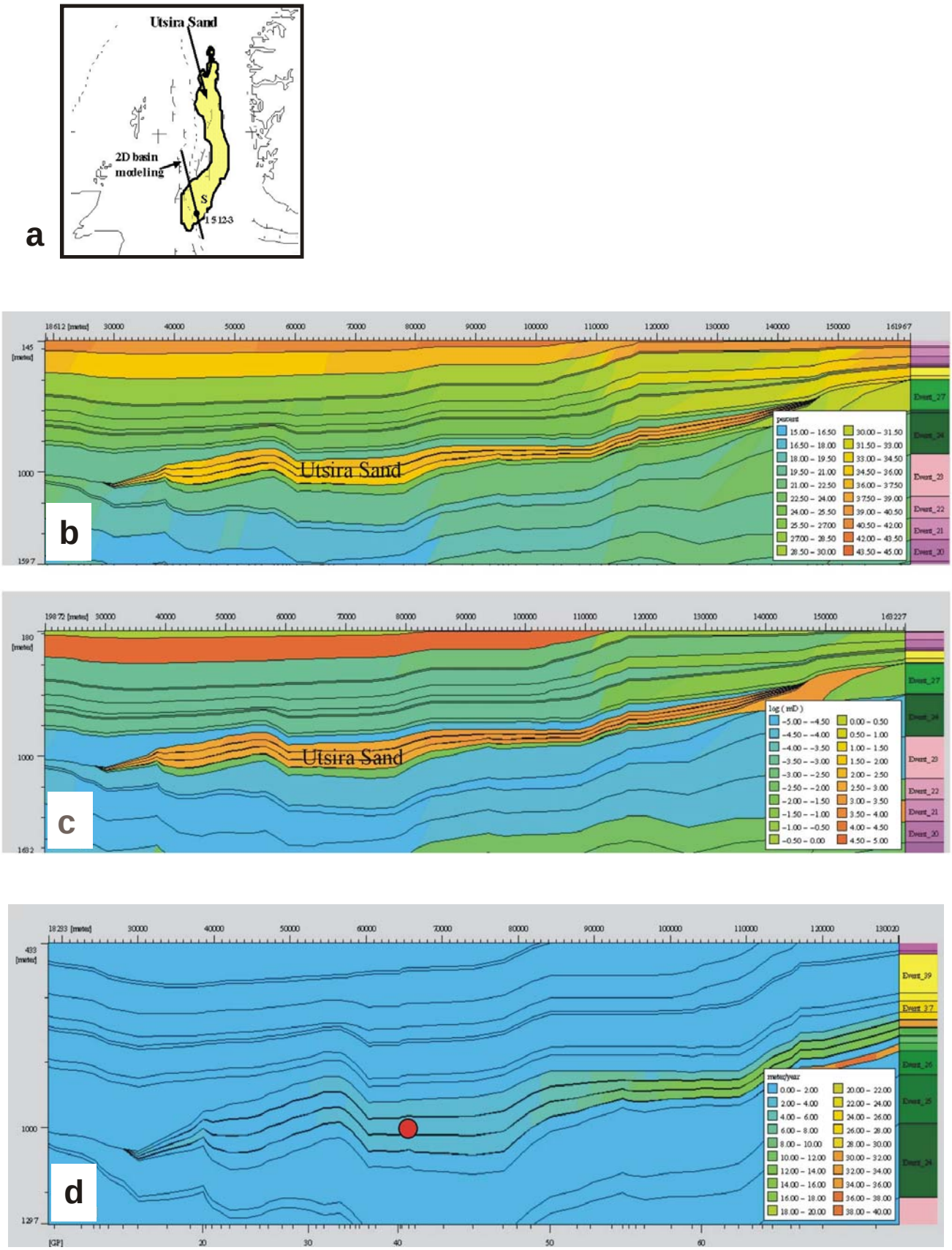


Figure 43. 2D basin model a) Location map b) Porosity of the Utsira Sand and surrounding formations c) Permeability of the Utsira Sand and surrounding formations d) Predicted present-day fluid flow velocity (metresyear^{-1}) due to sediment compaction.

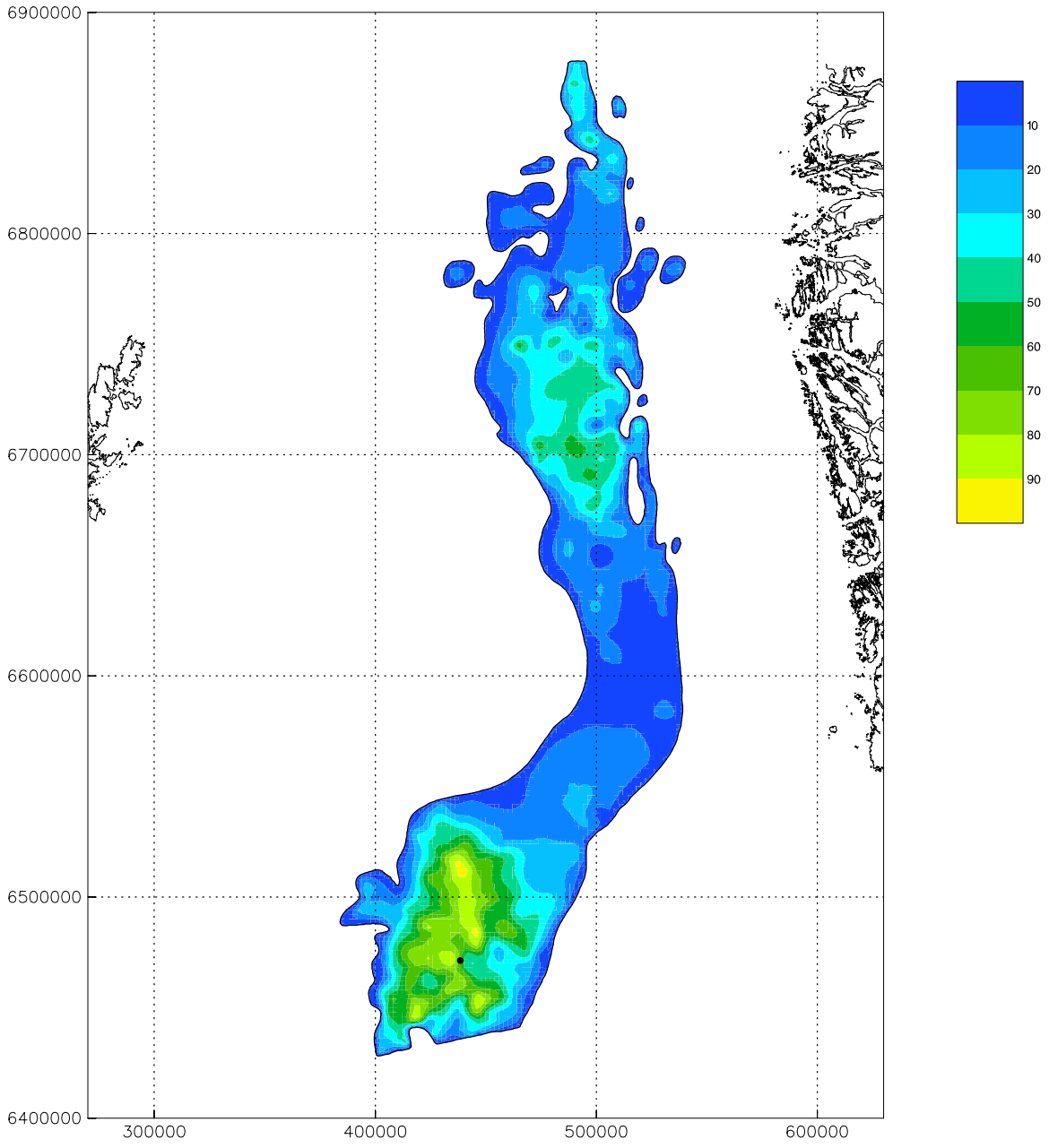
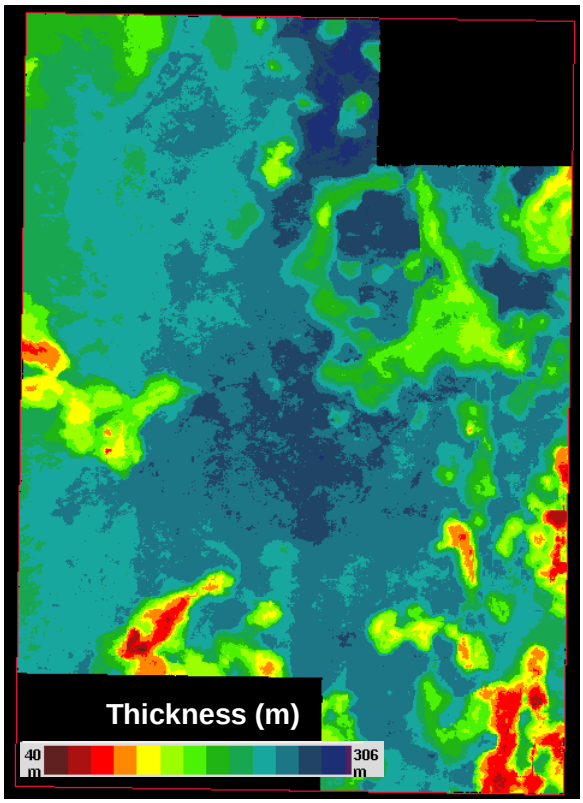


Figure 44. The Utsira Sand, total pore-space thickness (metres). Dot denotes CO_2 injection point.

a



b

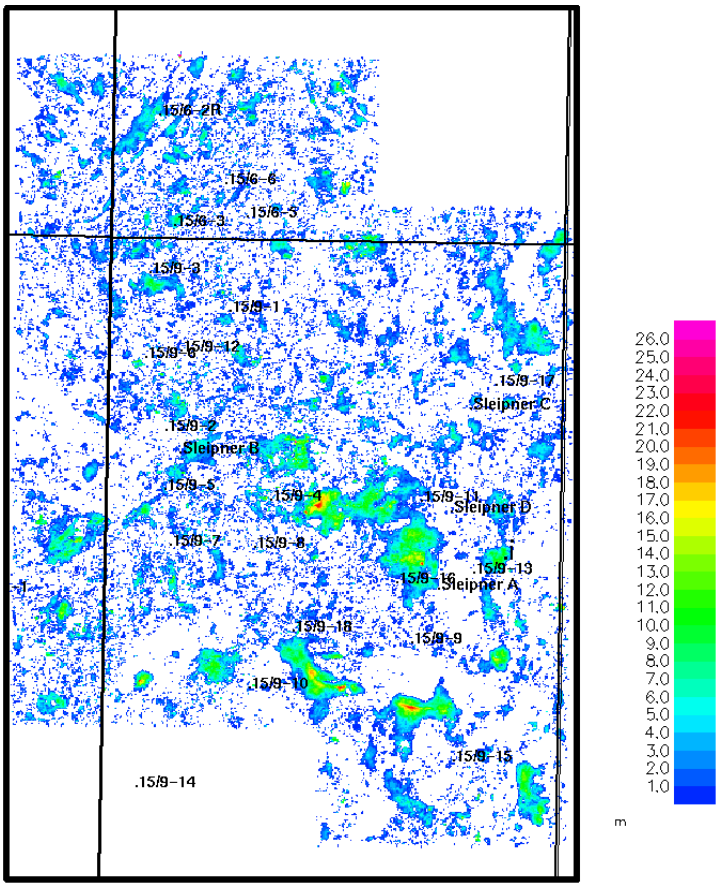
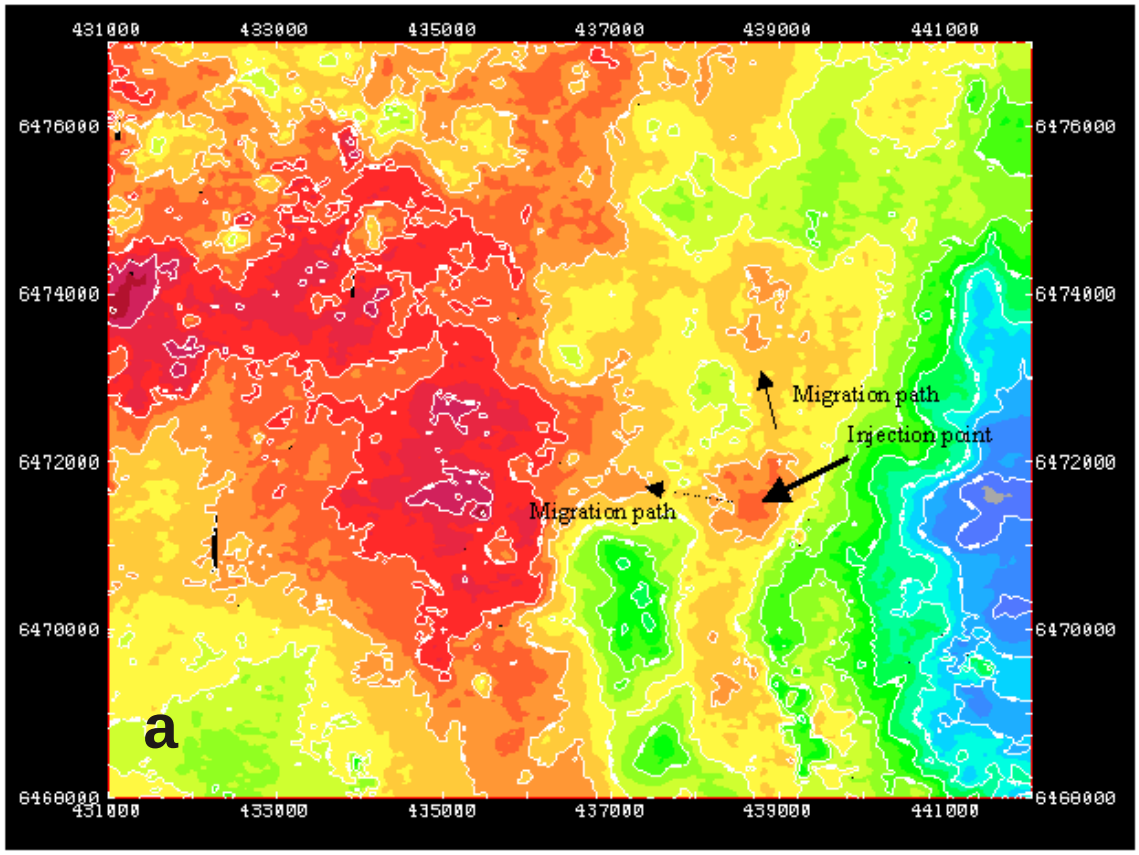


Figure 45. a) Survey ST98MT11 a) Utsira Sand thickness b) Structral traps at the top Utsira Sand. Colour scale gives height (metres) of trapped fluid column.



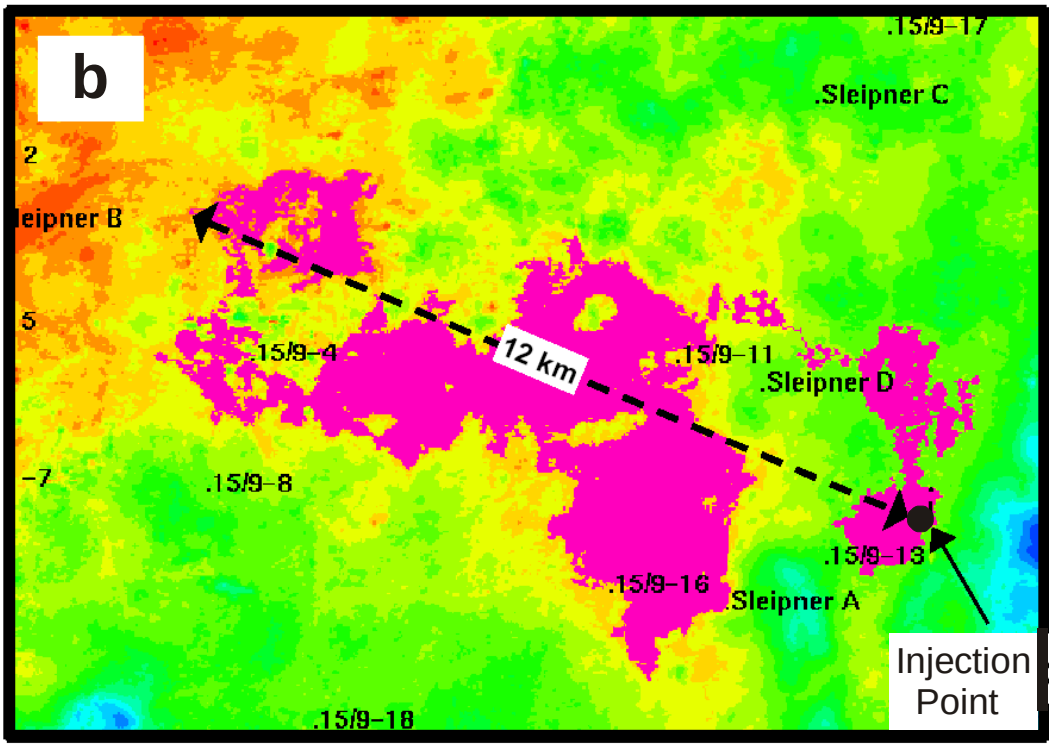
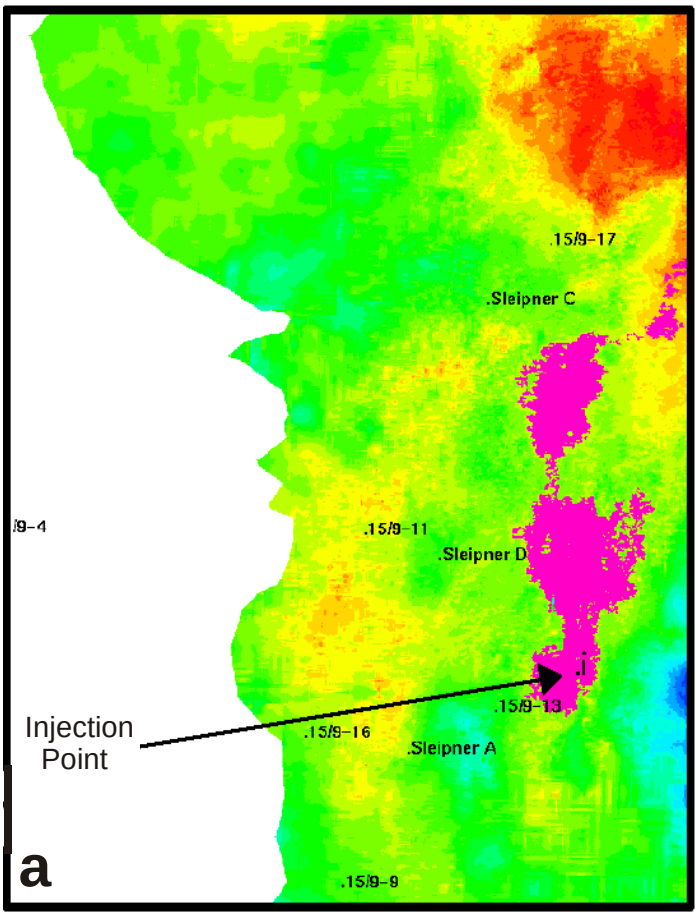


Figure 46. a) Detailed depth map of top Utsira Sand, showing potential initial migration paths from the injection point b) Final distribution of 30 x 10^6 m^3 (~ 20 MT) of CO_2 assuming migration beneath the top of the Utsira Sand.



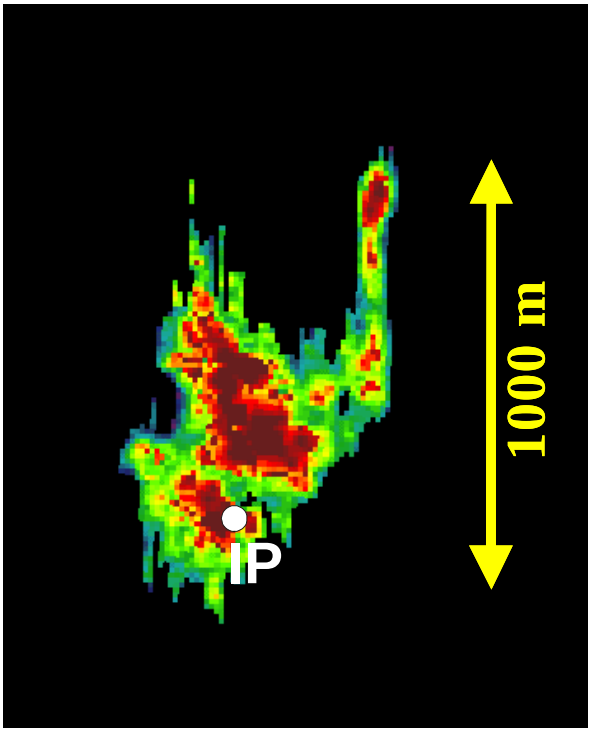


Figure 47. a) Final distribution of 7.4 x 10^6 m^3 (~ 5 MT) of CO_2 assuming migration beneath the top of the Sand-wedge. Note if more CO_2 is injected it will migrate out of the mapped area. b) Image of the CO_2 accumulation beneath the top of the Sand-wedge from the 2001 time-lapse seismic data. Note linear northward migration feature beneath possible channel-related feature.

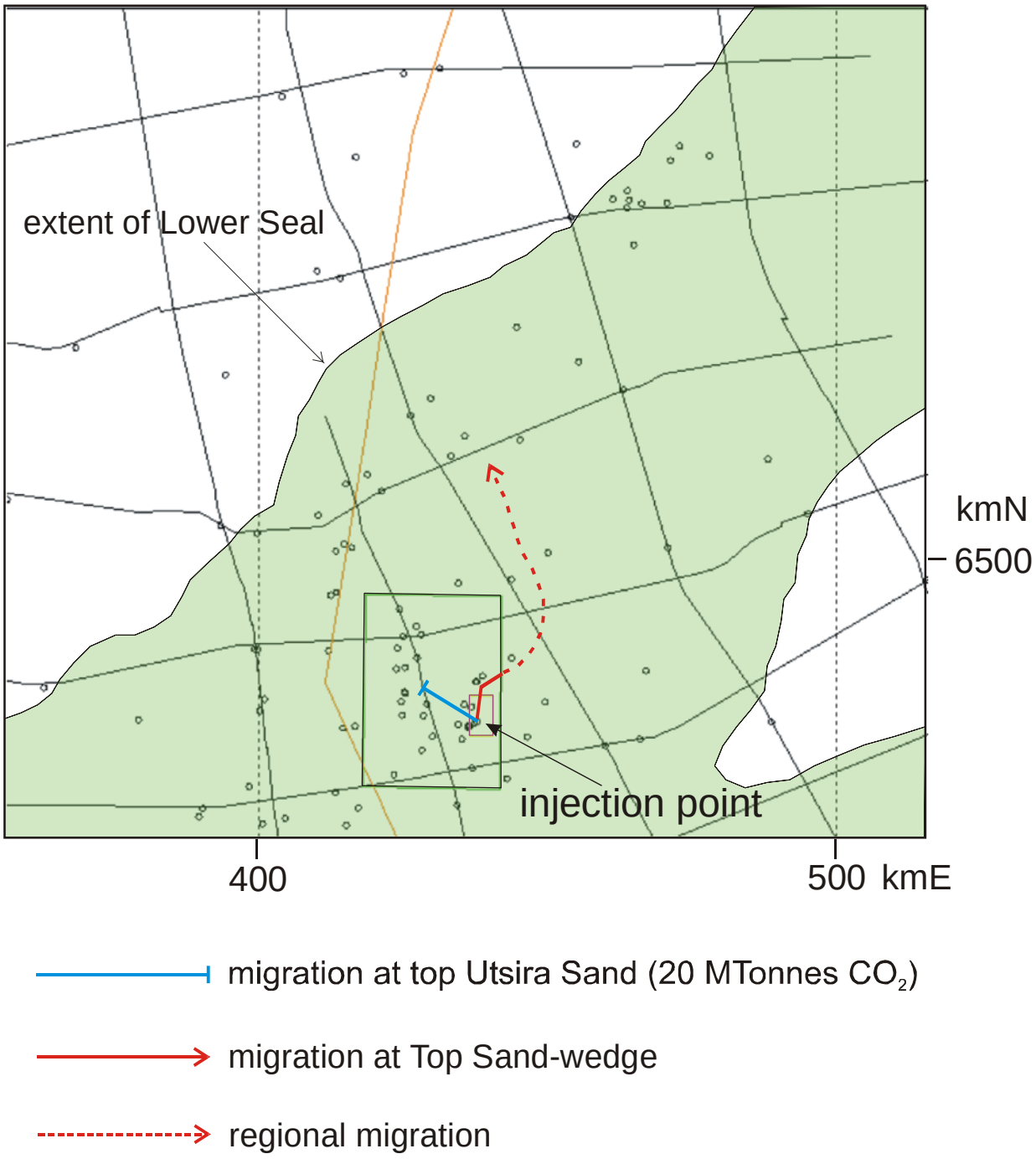


Figure 48. Regional migration trends from the Sleipner injection point. Large rectangle marks extent of ST98M11 survey, smaller rectangle marks 1999/2001 time-lapse surveys.