Kaizen Approach Leading to Success in North Sea Turbidites: Constant Revision of a Geological Model

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Introduction

In the Central Graben of the UK North Sea, Paleocene and Eocene turbidites were deposited during a period of active salt tectonics. A lack of understanding of the complex link between sediment transport, sediment deposition and salt activity led to many initial exploration failures. Constant innovation in geological concept has brought the oil companies time and time again to the same areas. A series of examples will outline some of the main misunderstandings associated with such tectonically controlled sedimentary basins.

The examples chosen will focus on the Forties, Sele, Rogaland and Tay formations in the areas of the Montrose High and of the Gannet and Guillemot Clusters. You have to remember that seismic for exploration was only 2D until Shell went for Exploration 3D Seismic in the 1993. Nowadays if 3D exploration is the norm in offshore waters, 2D seismic is still commonly preferred in many onshore exploration campaigns. Some of the learnings should be very useful in many other onshore world basins.

The most logical drilling spot may lead to exploration failure

In the Central North Sea Graben, drilling the apex of a nice seismic feature has often equated to drilling on the top of a salt dome. If the salt was actively growing at the time of sedimentation, that would mean **no sands or very limited sands** preserved in these shallower structural positions. Thus, most companies stopped their search in these areas after disappointing early exploration wells.

Second phase of exploration – new idea linked to synsedimentary salt tectonics

These companies were brought back in these areas after understanding the relative age of the salt activity with respect to the various known turbidites sands. The problem they faced then was, in many instances, the **size of the hydrocarbon pools** they found on the flank of the salt domes. In the early to mid nineties the threshold for commerciality was of the order of 75 million barrels. Clusters of discoveries were needed to add reserves and warrant a development.

Third phase of exploration – new idea linked to sands of different ages on opposite sides of salt features

Geochemistry gave a new observation that revitalized the exploration impulse in some of the areas. Thus in the Guillemot D area, well 21/30-1 encountered only 3 meters of oil in the Rogaland sand; the next well drilled (21/30-13) found a thick Forties sand package but the oil water contact was high and the reserves small.

Shell, the operator of this block, left the area again because of the low reserve estimates. In the lab, geochemists found out that the oil in the Rogaland sands and the oil in the Forties sands were different. Moreover, cores in well 21/30-13 showed blocks of Sele shales embedded in the Forties sands, indicating the relative age of the salt activity.

Shell came back looking for additional sands on the other side of the salt dome, with success. Tay Sand turbidites were present in well 21/30-14, however, thicknesses whereas satisfactory were still far from what was needed. Appraisal of well 14 with well 15 lead to disappointment as less sand was encountered. Every proposed correlation gave pessimistic views of the whole prospect.

When very detailed biostratigraphy comes to the rescue

Shell UK was known to be at the forefront of biostratigraphy in the Central North Sea. The correlations based on this top class biostratigraphy scheme had already been used with the models we commented upon. Theo Schroeder, the head biostratigrapher was going to retire when he asked funding for a small project. His extensive knowledge of Tertiary palynomorhs and pollens lead him to think that he could do a much more refined stratigraphy that should only be used in one part of the basin (previously all of the biostratigraphy was expected to be valid for the whole of the basin or the whole of the North Sea). He received the go-ahead for his additional project and delivered surprising results as the sands that we had correlated were of different ages. He gave evidence that younger turbidites could be present further away from the salt pilar. Shell found extra turbidite lobes and the field got to be developed under the name of the Gannet F Field.

Conclusions

Cores, geochemistry and detailed biostratigraphy have thus been essential in bringing, successively, better geological models that in the end made it all worthwhile. The field is small with respect to some other ones in the North Sea but the perseverance of Shell is worth a story.

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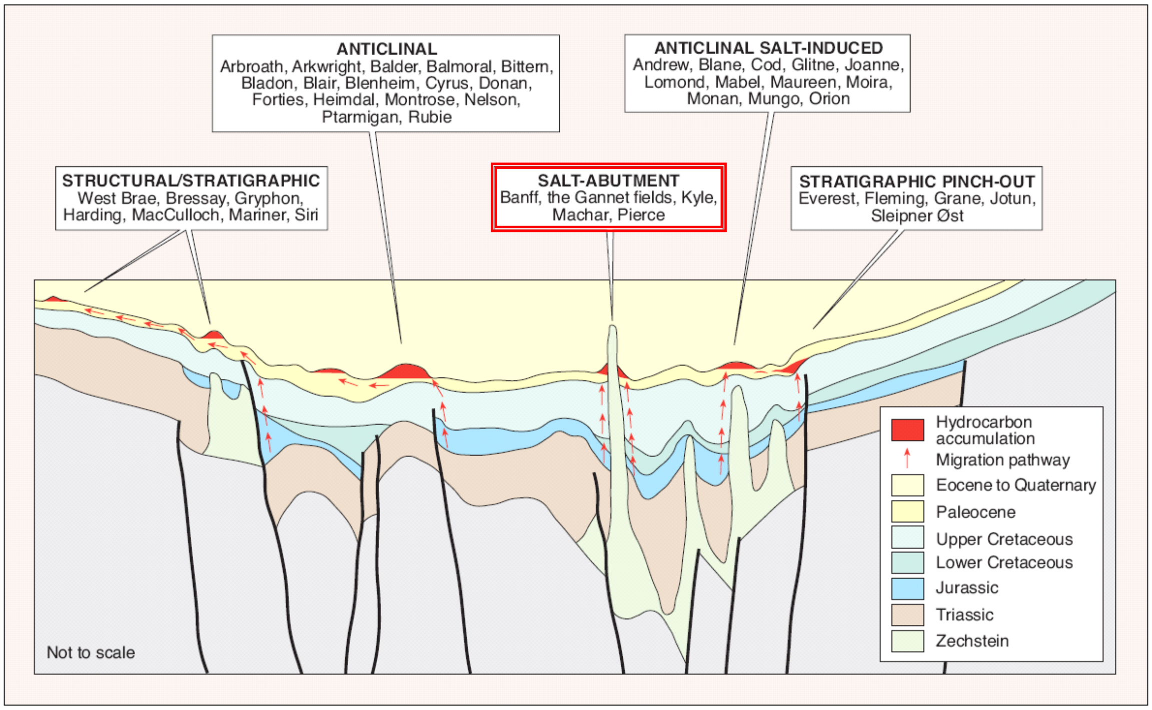

Fig. 1 Schematic representation of North Sea turbidite plays, after Ahmadi et al. 2003

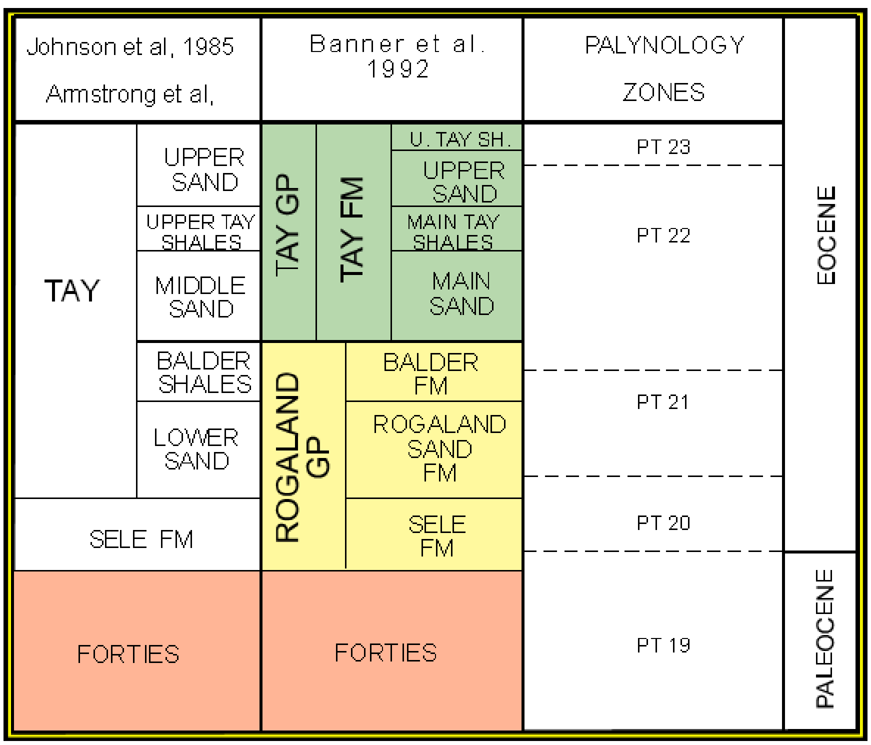

Fig. 2 Stratigraphy of the main turbidites plays in the Gannet Area (Banner et al. 1992)

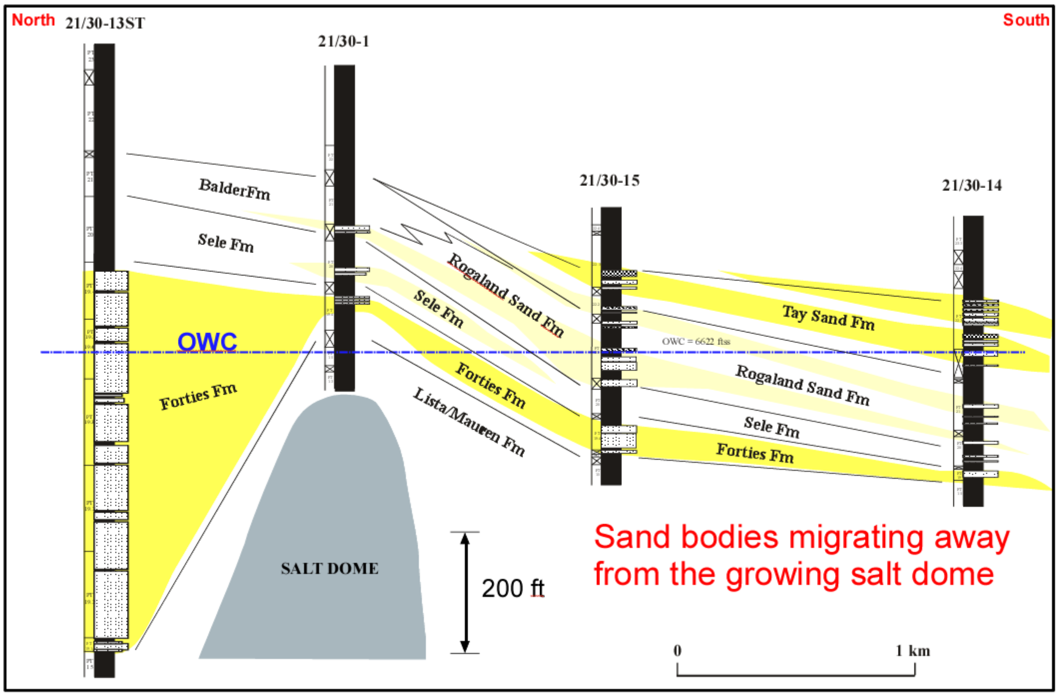

Fig. 3 North-South cross-section through the Gannet F Field

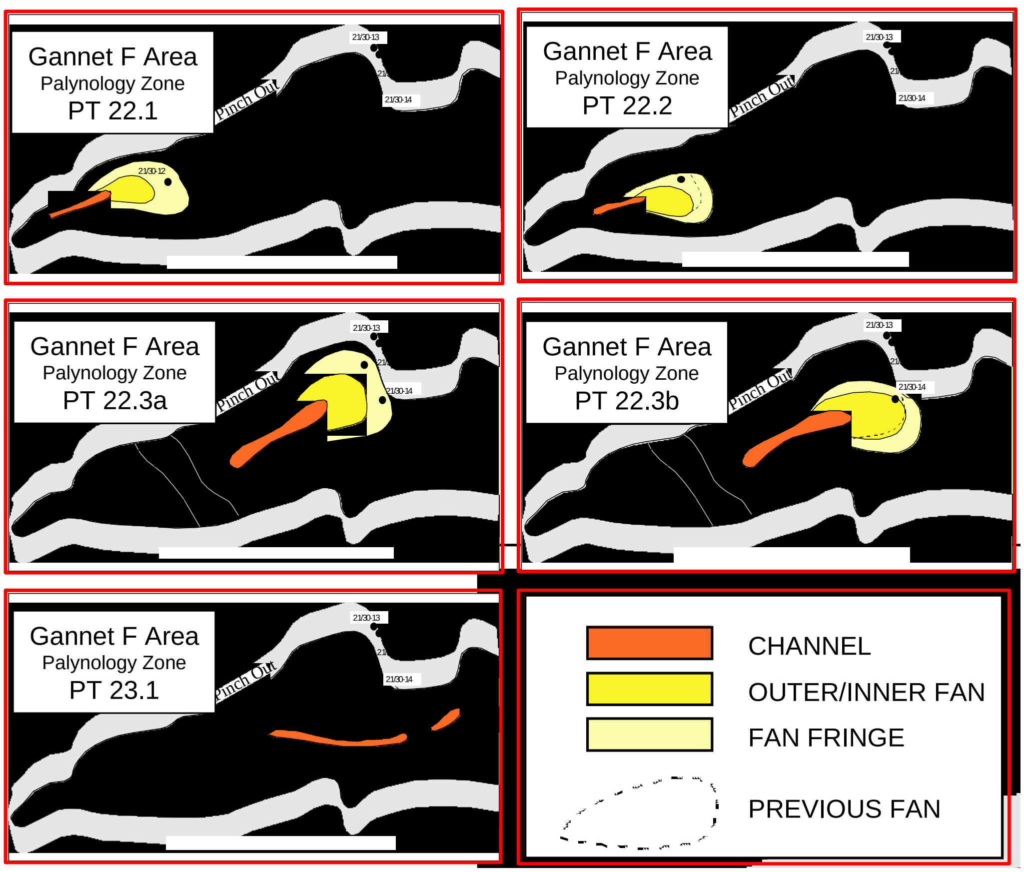

Fig. 4 Successive turbidite lobes filling a valley controlled by active salt tectonics