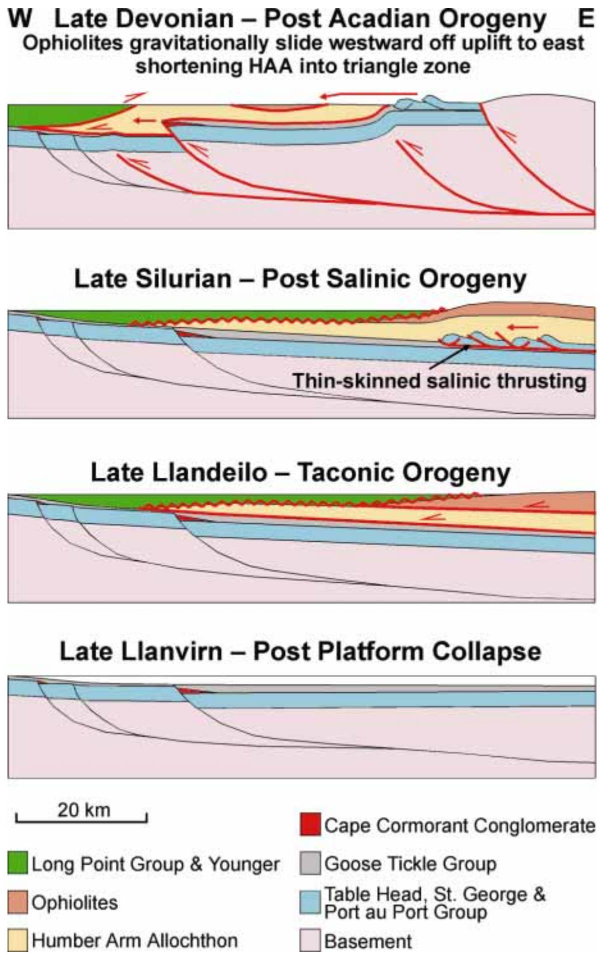


Fig. 14. Conceptual model of structural evolution of the Humber Zone (after Knight and Cawood 1991).

North Arm - Old Mans Pond Section

This cross-section cuts through the tectonic klippen in the Old Mans Pond area (Figs 1 and 15b). Between the Old Mans Pond Klippe and North Arm the Cambro-Ordovician platform stratigraphy is deformed into a complex of folds and thrusts that we suggest is the result of Salinic deformation. The structures locally deform the Humber Arm Allochthon but are in turn apparently deformed by the inferred basement involved deformation that creates the Penguin Arm monocline (Fig. 15b). Beneath the Old Mans Pond Klippe the Salinic structures are shown truncated by the basal thrust (Knight 1994). This may have resulted from later Acadian movement of the Humber Arm Allochthon as suggested by Knight and Cawood (1991). Beneath the ophiolites to the west of North Arm the structure of the Humber Arm Allochthon is unknown, however steep, variable dips are seen at outcrop surrounding the ophiolite suggesting structural complexity. The para-autochthon, in contrast, is probably only slightly deformed (Fig. 15b). The fault shown beneath the western margin of the ophiolites is highly speculative as the seismic data in that area is of poor quality (Line M-W-91-1595). The triangle zone monocline at the western end of the section is clearly seen on the seismic data (Lines M-W-91-1552, M-W-91-1595) as are the minor extensional faults in the autochthon.

Parsons Pond Section

This section runs from the Long Range inlier westwards through Parsons Pond and out into the Gulf of St. Lawrence (Figs 1 and 15c) where the structural geometry is poorly constrained by an old seismic line WN-2. The section is at the northern end of the Taconic allochthon outcrop (Fig. 1). At Parsons Pond, the surface structure is dominated by imbricate thrust slices of the Lower Head Formation and Cow Head Group. The Cow Head Group is the marginal debris flow facies of the Cambro-Ordovician Carbonate platform (James and Stevens 1986) initially thrust westwards during the Taconic Orogeny (Knight et al. 1991). The platform beneath the allochthon is elevated on a series of basement - involved faults that may have originated as extensional faults. These faults outcrop to the north of Portland Creek Pond and can be seen on seismic data 10km north of this cross section (Line IEX-NOR-89-2). As the Cambro-Ordovician platform is exposed east of the Cow Head Allochthon the basal thrust must outcrop at the eastern edge of the allochthon. This parautochthonous platform sequence rests unconformably on basement, in a fault-segmented monocline at the western edge of the Long Range inlier, with only a minor displacement on the Long Range Thrust (cf. the 15km displacement of Knight and Cawood, 1991, fig. 46 C-C'). One of these faults, the Parsons Pond Thrust has been interpreted as an inverted extensional fault by Stockmal et al. (1998) based on thicker Goose Tickle Group sediments including the locally developed Daniels Harbour member in the hanging-wall. The Daniels Harbour member is similar in origin to the Cape Cormorant Conglomerate to the south. Offshore, the seismic data shows that the Taconic and Salinic Foreland Basin megasequences form a homocline dipping west above an imbricated wedge of the Taconic Allochthon. Extensional and compressional faulting shown in the platform, and beneath the Taconic Allochthon wedge, is purely speculative

Port au Choix to Williamsport Section

The section runs from just to the west of Port aux Choix across the Long Range inlier to the east coast of the Northern Peninsula (Figs. 1, 15d). In the vicinity of Port aux Choix a large number of faults have been mapped by Knight (1991, 1997). These faults are interpreted as predominantly east-dipping thick-skinned faults some of which are probably extensional faults that have been in-

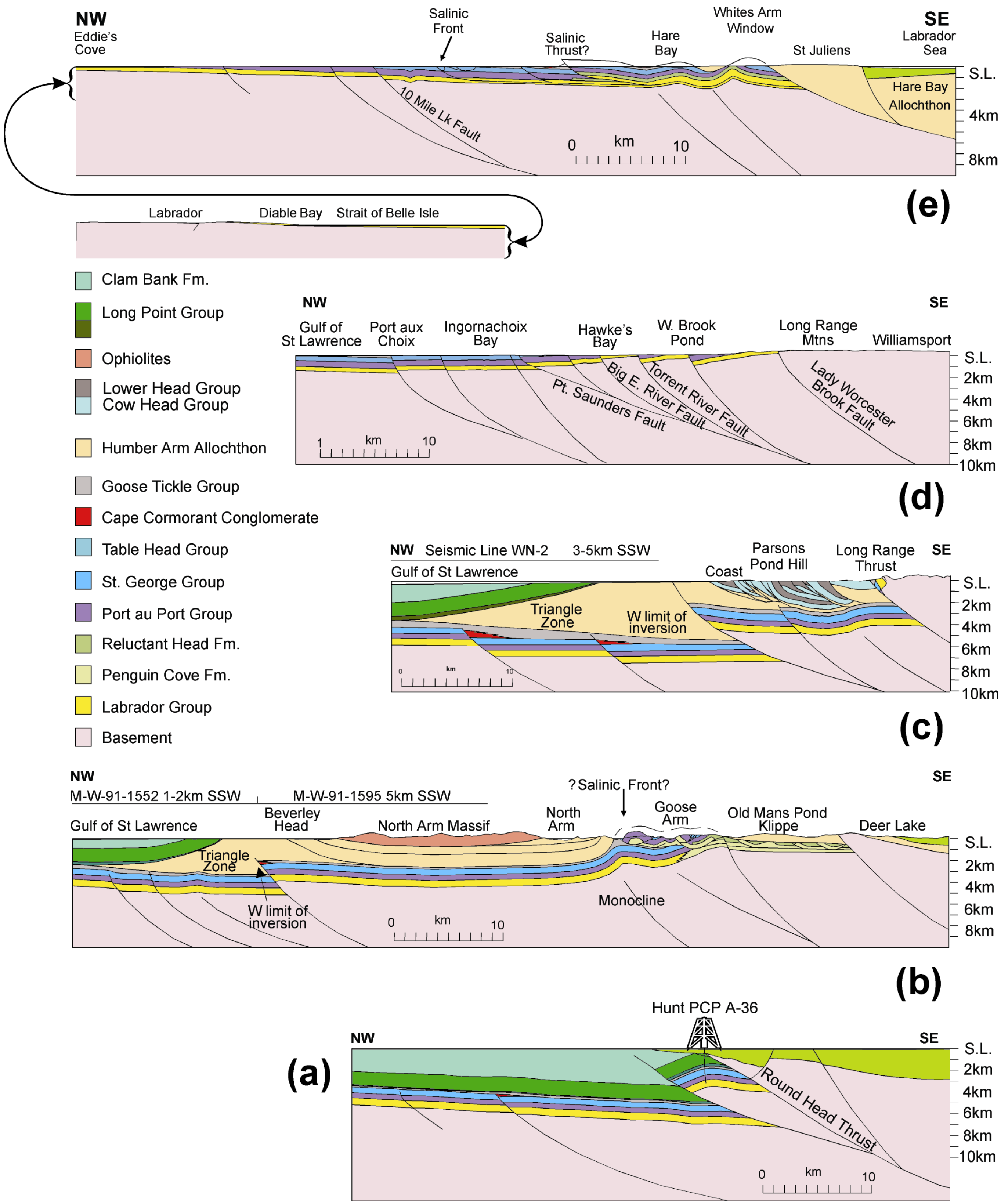


Fig. 15. Regional cross-sections to illustrate structural style variations, for locations see Fig. 1.

blocks onshore (op cit. fig. 1).

Labrador - Hare Bay Section

This section is located at the northern end of the Northern Peninsula and runs from Labrador, across the strait of Belle Isle, through Hare Bay to the east (Figs. 1, 15e). The western part of the section shows a thin veneer of Cambrian siliciclastics resting uncomformably on the Grenville basement. A few extensional faults, some of which show (?) Acadian inversion, cut through the sediments and crystalline basement. Thin-skinned deformation which results in significant shortening is only seen at the eastern end of the section within the Salinic fold and thrust belt. This is subsequently deformed during Acadian inversion of the extensional faults causing folding of the Salinic thrusts. To the north, the Salinic thrust front merges with the northern extension of Ten Mile Lake fault and emerges on the northern coast. The Salinic deformation imbricated the facies transition in the Cambrian from neritic platform sediment to the deeper water equivalents of the Reluctant Head and Penguin Cove Formations. The change in deformation intensity across the Salinic Front is remarkable. To the west in the Salinic foreland the sediments show no pervasive ductile deformation. At the Salinic Front equivalent age rocks are pervasively deformed by semi-brittle shear zones, calcite filled vein arrays and a locally developed cleavage. An alternative model is that the Cambro-Ordovician at outcrop is allochthonous. Any prospective structures would be in the autochthonous Cambro-Ordovician platform in the footwall of the inferred thrust. This alternative model is not credible as there is no major thrust outcrop at surface; the only place such a thrust could be located is in the Strait of Belle Isle. However, dip and stratigraphic data onshore and the seabed geology are consistent with a simple homoclinal dip panel, (Woodworth-Lynas et al. 1992) cut by a few high angle extensional block faults. In addition, the northern end of the Long Range Mountains has a conformable overmature sequence from basement to the Ordovician carbonates, thus the entire Long Range inlier would have to be considered part of an overthrust sheet with mature source rocks and reservoirs buried beneath.

Structural Trap Configuration

The structural trap configuration tested to date in this trend is the footwall shortcut anticline developed during Acadian thick-skinned compressional deformation (Fig. 16). In the case of the Round Head Thrust this was due to the inversion of an extensional fault developed during the Syn-Rift and Flexural Bulge megasequences. The fairway is defined to the east and north by the eastern thrust edge of the Humber Arm Allochthon; beyond this area the potential reservoir section is at surface (Fig. 16). The southern edge of the fairway is defined by the outcrop of the top of the platform on the Port au Port Peninsula and the footwall cut-off of the platform against the Round Head Thrust. To the west the fairway limit coincides with the western limit of Acadian thick-skinned compression which can be seen clearly on some of the offshore seismic data but has to be inferred on other lines in the data set. Further to the west extensional faults developed during the Syn-Rift and Flexural Bulge megasequences have not been inverted and retain their original extensional geometry (Fig. 16). There are a number of the faults visible on the offshore seismic data set used to construct the cross-sections, (Fig. 15). The western limit of this extensional fault block fairway is not known as structures of this type can be seen at the western ends of several lines from the offshore data set.

RESERVOIR DISTRIBUTION AND DEVELOPMENT

Stratigraphy and Lithofacies of Reservoir Units

The primary target reservoirs are the Cambro-Ordovician carbonates of the Port au Port and St. George groups. Strata were deposited in shallow subtidal to peritidal environments, as shallowing upward parasequences, 1-10m in thickness. In the St. George Group, the subtidal cycles are up to 5 m thick and consist of burrowed peloidal wackestones/mudstones, commonly overlain by grainy thrombolitic boundstones or parallel laminated peloidal packstones to grainstones. Crossbedded grainstones and fenestral grainstones dominate locally and major thrombolite- grainstone mound complexes also occur widely on the shelf. The peritidal cycles, 1m thick, consist of thin bedded peloidal mudstone to packstone overlain by wavy laminated, fenestral laminated to massive, or stromatolitic mudstone. In the Port au Port Group oolites are more common. Cowan and James (1993) identified six types of metre-scale cycles, three peritidal (desiccated laminite, oblate bioherm and ribbon rock/equant bioherm), and three subtidal (ribbon rock, oolite and large microbial bioherms). These cycles all probably represent fifth or sixth-order parasequences.

Two third order sequences 250-300 m thick occur in the potential reservoir section in the Port au Port area (Knight and James 1987 and Fig. 17). The basal sequence boundary of the lower sequence is within the stacked, small-scale peritidal parasequences in the Berry Head Formation, approximately 30-40 metres above the base (Fig. 17). This represents a time of minimum accomodation on the platform (c.f. Cowan and James, 1993, who defined this sequence boundary somewhat lower, at the base of the Berry Head). The upper boundary is taken at the Boat Harbour disconformity (Fig. 2). The younger third-order sequence is bounded by the Boat Harbour disconformity at the base and the St. George unconformity at the top.

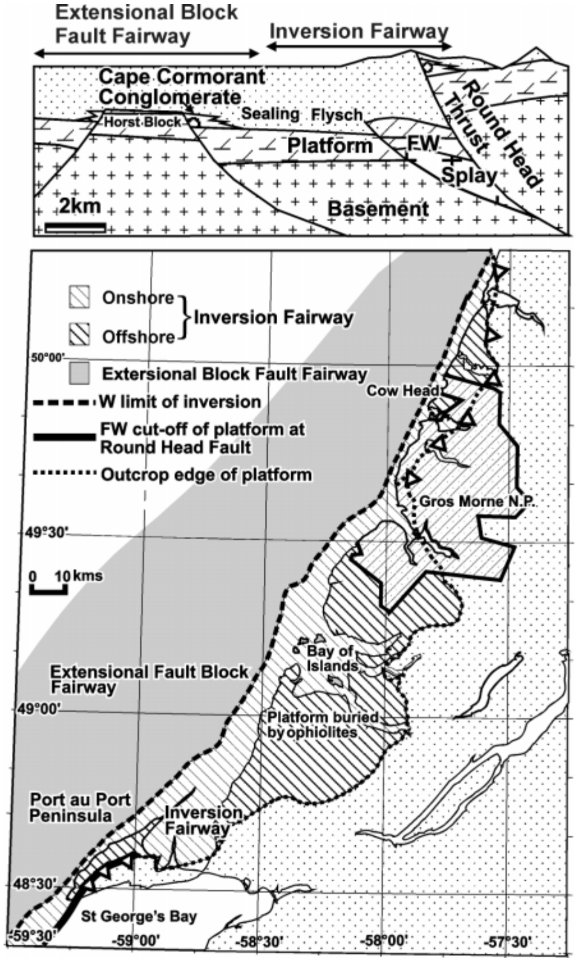


Fig. 16. Structural trap fairways in the Humber Zone of West Newfoundland.

Both third-order sequences have a similar internal facies architecture. The basal part consists of dominantly peritidal lithofacies, in thin parasequences; the middle is mostly subtidal lithofacies, in somewhat thicker parasequences; while the upper portion is again dominantly peritidal. The lithostratigraphic units of the carbonate platform correspond roughly to these lithofacies; the muddy Boat Harbour and Aguathuna formations are largely peritidal lithofacies, whereas the grainier Watt's Bight and Catoche formations consist mostly of subtidal lithologies. As described below, the textural attributes of these lithofacies ultimately affect reservoir quality at depth (Fig. 17).

Dolomitization Processes and Evidence of Karst

Haywick (1984) identified four different types of dolomite in the St. George Group of western Newfoundland. Early dolomite was associated with inter- and supratidal environments, such as fenestral mudstones and cryptalgal laminites, probably due to periodic exposure and evaporative conditions. Finely crystalline "matrix/ mottle" dolomite was identified and attributed, using cross-cutting petrographic relationships with stylolites, to early burial processes. "Pervasive A" dolomite is fine to medium crystalline, coincident with the matrix/mottle phase, and possibly related to mixing of marine and meteoric waters. Lastly, a phase of recrystallization, "Pervasive B" dolomite, was associated with dissolution of matrix and allochems, followed by precipitation of coarse white dolomite cements.

On the Port au Port peninsula there is abundant dolomite present in the platform outcrops, but little apparent reservoir quality. The peritidal dolomites, such as those of the Aguathuna Formation are invariably tight. There is evidence for erosion, on the order of tens of meters, at the St. George Unconformity (e.g. fig 6 in Knight et. al., 1991). Karst features such as cave-fill and solution pipes have been described by Kerans (1989) from the time-equivalent Ellenburger Formation of west Texas. Discordant and bedding parallel matrix breccias support cave development in the Aguathuna Formation and shale filled caves are also common in the upper part of the Catoche Formation. Bedding parallel caves with no collapse breccia or shale infill occur in the Aguathuna Formation and probably formed open caverns in the sub-unconformity cave system. The dolomitized subtidal lithofacies are medium gray, fine to medium crystalline dolomites, with irregular dissolution vugs ranging from 2 to 20mm in size. Samples from the Catoche Formation have a porosity of 5% but permeability of only .06 md, indicating that the matrix is effectively tight.

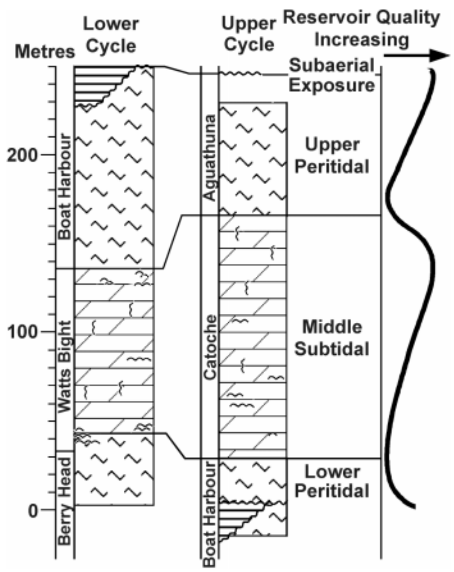


Fig. 17. Third order sequences of the upper Port au Port and St. George groups (after Knight and James 1987).

Reservoir Quality in the Wells

Not surprisingly, the hangingwall section of the Port au Port #1 well was similar to in the contiguous outcrop. Log porosities in the carbonates were low, generally less than 4%, by contrast, in the footwall of the Round Head Thrust several porous zones occur. The first is immediately below the St. George Unconformity, in the Aguathuna Formation. The zone is 18.5m thick and averages 9.8% porosity and 21md permeability. On the FMS log there appear to be caverns (Fig. 18) interpreted as karst beneath the St. George Unconformity. This interval produced oil at maximum rates of 1750-2400 bbls/d with approximately a 25% water cut at pressures of 25 Mpa. Several metres above and below the caverns vuggy, sucrosic dolomites, with a possible zebra-dolomite texture occur. Drill cuttings contain abundant sparry white dolomite, pyrite, galena and sphalerite, consistent with high density log readings over the same interval. The well produced a cumulative volume of 5012 bbls of oil and 2737 bbls of water on production test over a 7 day period at variable rates with a gradual decrease in rate and pressure (Fig. 19). The origin of this drop in productivity is uncertain. It could be due to waxing and/or salt precipitation around the perforations or it could reflect depletion of a small oil accumulation.
The underlying Catoche Formation is also extensively dolomitized, but is not as porous with 15m of 8.7% average porosity. Some white dolospar is present in drill cuttings, but there is no indication of Pb-Zn mineralization. The interval 3515 - 3600m flowed 800 bbls/day of formation water.

The deepest reservoir interval occurred in the Watt's Bight Formation, between 3515-3559.5m. Three "cavernous" zones were encountered into which 5450 barrels of drilling mud were lost. White dolospar, pyrite, galena and sphalerite were again common in the drill cuttings. Logs indicated that there were porosities of up to 30% (mean 14%) with no indicated hydrocarbons. The low sonic velocity and large calliper response suggested the development of three large cavernous voids and an anomalously high density response is interpreted as sulphide mineralization lining the void walls. When tested the zone produced formation water at 1500 – 4000 bbls/d at a pressure of 40 Mpa.

Reservoir development in the Long Point M-16 well was generally poorer than in Port au Port #1 (Fig. 20). Both the Aguathuna and Catoche formations were tight, the latter being only slightly dolomitized. The Watt's Bight Formation contained 13m of 7% porosity. The interval calculated wet on resistivity logs and was not tested. White dolospar was present in drill cuttings, but no Pb-Zn sulphides, so the zone may be more texturally analogous to the Catoche Formation in Port au Port #1.

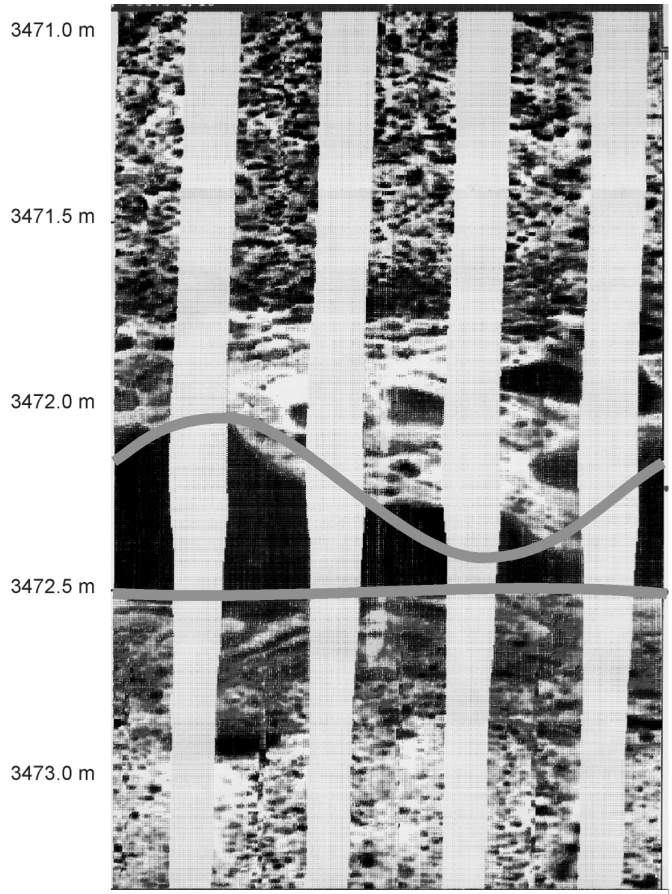


Fig. 18. Cavern development in the Aguathuna Formation beneath the St. George Unconformity seen on an FMS image.

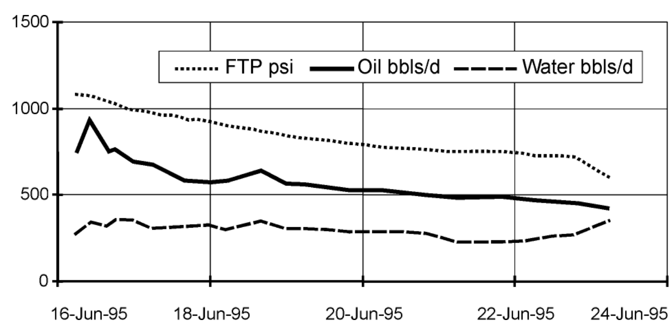


Fig. 19. Production test rates and pressures, Aguathuna Formation, Port au Port #1 well.

The A-36 well encountered a largely dolomitized, but tight interval at the top of the carbonate platform (Fig. 20). The core taken at 2040.6-2049.8m in the Aguathuna Formation consisted of tight, peritidal laminated mudstones to packstones with pin-point oilstain in the matrix and along fractures. The second core at 2422.9-2438.1m in the Watts Bight Formation consisted of moderately porous, mostly subtidal thrombolitic boundstones with common white dolospar, respectively, and Pb-Zn mineralization. The Watts Bight Formation contained a 14m zone 2440-2455m (Fig. 21) with cavernous porosity development (net 8m of 12.9% porosity) can be interpreted as Zebra Dolomite on the FMI log. This interval produced a gas kick on penetration but logs indicated that the zone was wet.

Reservoir Development Model

The pre-drill reservoir model was based on descriptions of the Ellenburger play of West Texas which has a significant karst component as described by Kerans (1989) and (Lucia, 1995). Integration of outcrop studies and the well data suggests that a paleokarst was probably relatively minor in creating the observed porosity-permeability system. The proposed reservoir model (Fig. 22), is intimately related to extensional collapse during the Flexural Bulge Megasequence. The dominant mechanism for reservoir quality creation was a hydrothermal system of dolomitization, linked to the tectono-stratigraphic history of the area.

In the Late Arenig (Fig. 22), a eustatic sea level fall produced the St. George unconformity, while the incipient Taconic orogeny caused the platform to breakup and collapse as a series of fault-bounded blocks. Tilting of these blocks during collapse caused some preferential subaerial erosion on the resultant topographic highs. Some dissolution and porosity enhancement probably occurred at this time, as suggested by the solution collapse and karsting features previously described. Erosion would primarily have affected the peritidal dolomites of the Aguathuna Formation. The thickness of the Table Head Group, deposited above the unconformity, can be used to infer the relative topography of each fault block.

Continued foundering of the platform during the Flexural

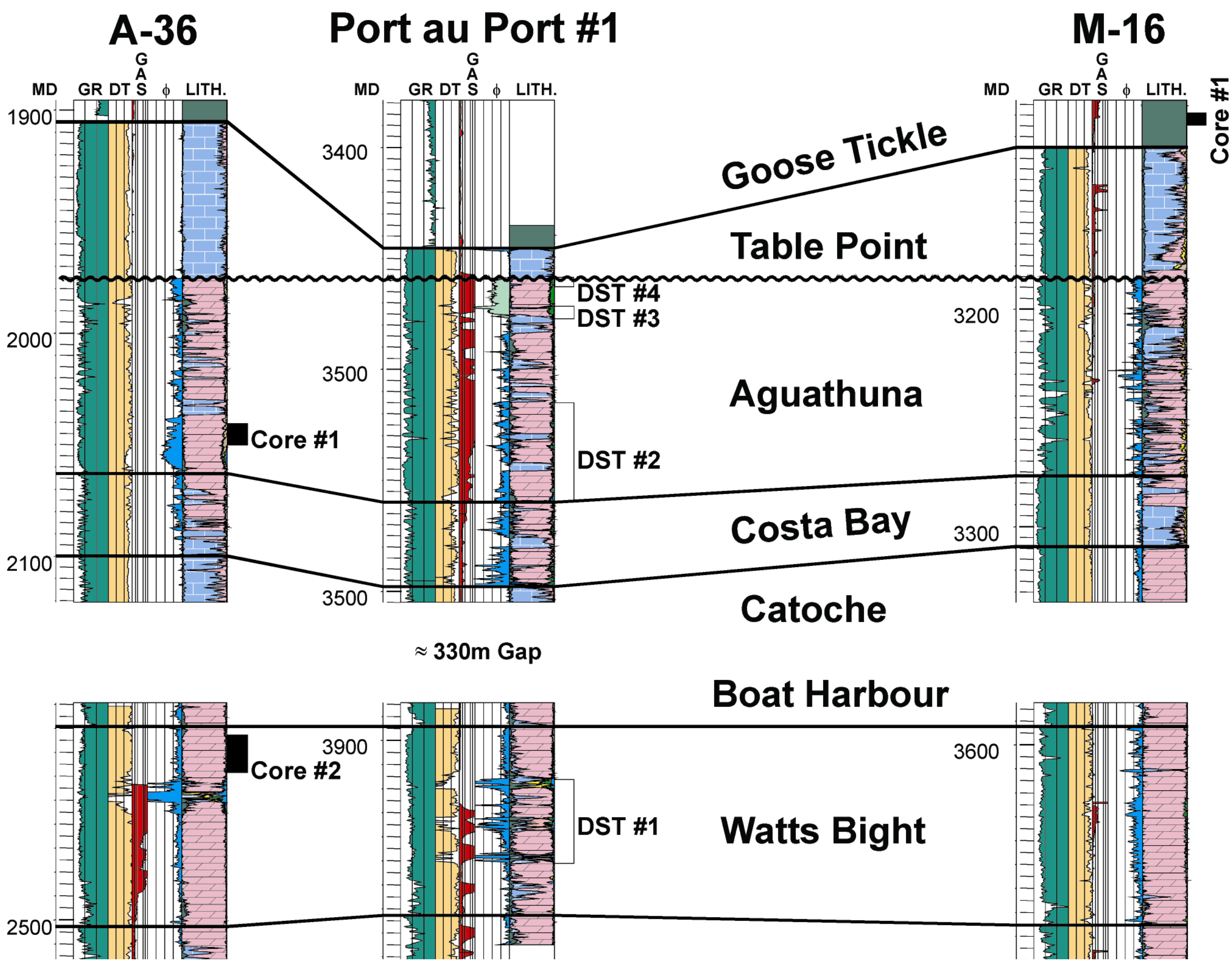


Fig. 20 Log correlation of stratigraphic formations between the A-36, Port au Port #1 and M-16 wells. MD, measured depth in metres; GR, gamma ray in API units; DT, sonic in microsecs/metre; GAS, Total mud gas in units;φ, porosity % (blue, water filled; green, oil filled); LITH, calculated lithology. Locations of cores and DST intervals are shown.

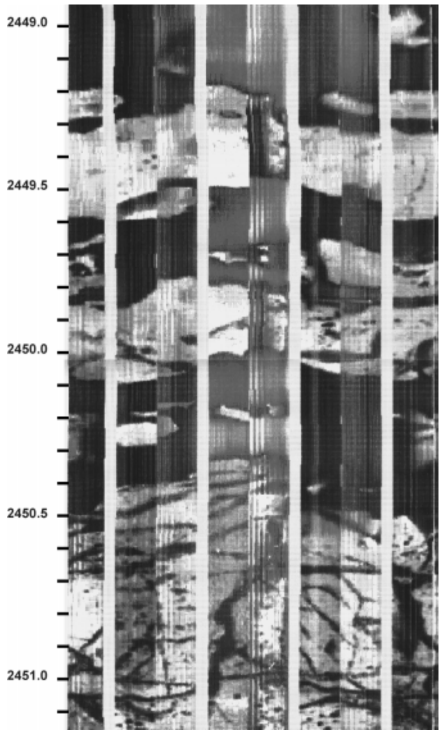


Fig. 21. Zebra dolomites on an FMI log from the Watts Bight Formation, A-36 well.

Bulge Megasequence in the Late Llanvirnian, (Fig. 22), caused differential subsidence of the various fault-bounded blocks. Topographic highs continued to be subaqueously eroded with debris deposited as the Cape Cormorant conglomerate on topographically low blocks. Dating of clasts in the Cape Cormorant Formation (Stenzel et al. 1990) demonstrate that the throw on the Round Head Fault was sufficiently large to erode the Port au Port Group.

By early to mid- Devonian, the platform had been buried under the Taconic and Salinic foreland basins (Fig. 22) and Acadian tectonism was occurring to the east. This could have caused the movement of hydrothermal fluids up the major faults bounding the platform blocks. A similar model of fault-focussed mineralizinf fluids related to Appalachian deformation has been proposed for the development of the Ozark Mississippi Valley type PB-Zn deposits (Clendenin and Duane, 1990). The fluids migrated up to the highest topographic point until they reached a significant permeability barrier, the Goose Tickle Group. This controls the distribution of hydrothermally altered rock in the upper Aguathuna Formation which is preferentially seen on the paleo-highs. Hydrothermal alteration also occurred in porous units lower in the platform on the fault block crests, most notably in the Watt's Bight Formation. Hydrothermal fluids would have flowed preferentially into this, and other porous and permeable units in the platform, that were connected to the main fault conduits.

This model is consistent with the observed mineralization and reservoir development in the platform. Hydrothermal alteration (and porosity development) is greatest at the crest of fault blocks with the thinnest Flexural Bulge Megasequence e.g. in the footwall of Port au Port #1, in grainy, subtidal units in the platform that were porous and permeable at the time of fluid migration (e.g. Watt's Bight Formation). Conversely, mineralization and porosity/ permeability development is poorest in topographically low fault blocks (e.g. Port au Port #1 hanging wall) and in the shallow, peritidal lithofacies. The relationship of the hydrothermal event to the Acadian orogeny is corroborated regionally by isotopic evidence from the Daniel's Harbour mine to the north where the Pb-Zn mineralization is hosted in the Ordovician platform yields an approximate early Devonian (pre-Acadian) age (Lane, 1990). Lead-zinc mineralization is seen in many areas of the eastern Port au Port Peninsula and locally in the western part. Some of this mineralization is locally related to Carboniferous vents, (von Bitter et al. 1990, Saunders et al. 1992).

The Long Point M-16 well is interpreted as a topographic low, due to the significant thickness of Table Point Formation drilled (Fig. 20) and structural location; the well encountered little porosity or permeability (Figs 11 and 5). The best porosity in the well was in the middle of the Watt's Bight Formation, correlateable to the 'cavernous zones' in the Port au Port #1 and A-36 wells, suggesting textures susceptible to hydrothermal alteration. Although A-36 encountered 70m of the Table Point Formation, it was located closer to a syn-rift topographic higher than the M-16 well (Fig. 15). The lack of more extensive hydrothermal alteration in the shallower units at A-36 may be explained by its distance from the Round Head fault (ca. 5km, Fig. 15a).

Additional evidence corroborating the reservoir model is provided by field mapping of a paleo-high at Port aux Choix (Knight 1997 and Fig. 23). Interestingly, the upper part of the porous body is pervasively stained with bitumen, while the lower part is not. The base of the bitumen staining is a contact which can be mapped as essentially flat in the field and may represent a paleo-oil/water contact, making the mapped porosity an exhumed oil field. The oil would have been emplaced in the Devonian; and the reservoir breached when the cap rock of Taconic/ Salinic flysch was eroded, leaving the platform exposed at surface. The discovery of an exhumed oil reservoir of this size along strike from the play trend, is an encouraging sign that similar traps may still exist in the subsurface.

Other Potential Reservoirs

The Port au Port #1 well encountered porous streaks (64m of 12.2% porosity) in the clean quartz arenites of the Hawkes Bay Formation, in the hangingwall of the Round Head Thrust. In the footwall the Hawkes Bay Formation was tight with maximum porosities of only 5%. This difference in porosity between the footwall and hangingwall penetrations of the unit is attributed primarily to differences in the post-Acadian depth of burial which affected the amount of cementation. In the A-36 well the Hawkes Bay Formation had 31m of 10% (mean) porosity but calculated wet on logs.

HYDROCARBON GENERATION AND MIGRATION

Source Rocks

There is

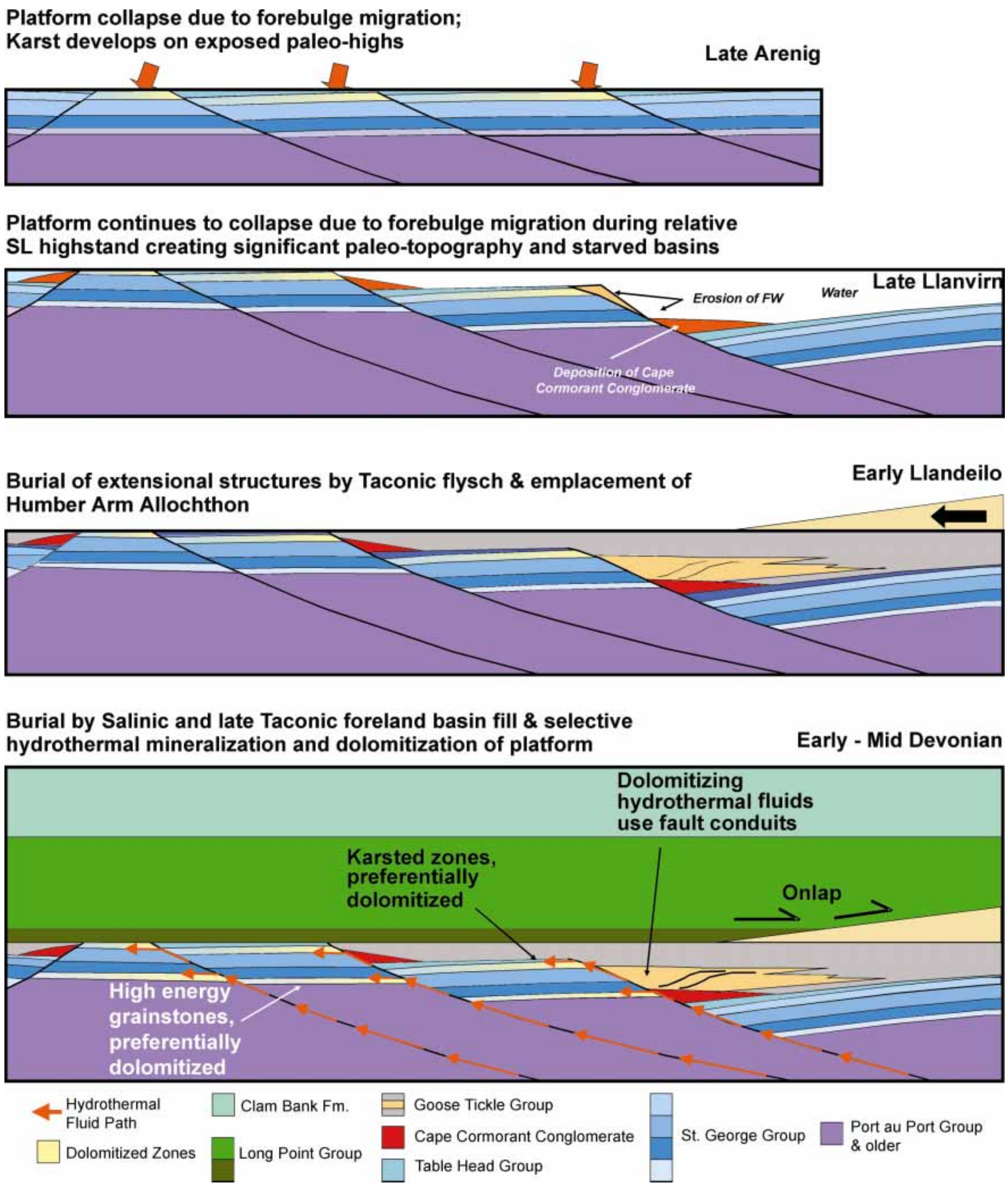


Fig. 22. Model of reservoir development based on data from the wells and outcrop studies (e.g. Knight 1997); see text for discussion.

good source rock potential in the Humber Arm Allochthon with high TOC shales (Weaver and Macko 1988, Sinclair,1990 and Fowler et al. 1995). The oil in the Port au Port #1 well was typed to these source rocks (Martin Fowler pers. comm.).

Maturity Data and Burial History

Maturity indicators in well cuttings included vitrinite reflectance, conodont colour alteration index, graptolite reflectance and acritarch colour. The data shows a general pattern of increasing maturity levels with depth (Fig. 24) and is consistent with surface samples (Williams et al 1998). In the Port au Port #1 well the maturity of the Port au Port and St. George groups in the footwall and hangingwall of the Round Head Thrust are identical (Fig. 24) suggesting that maximum burial was achieved prior to the

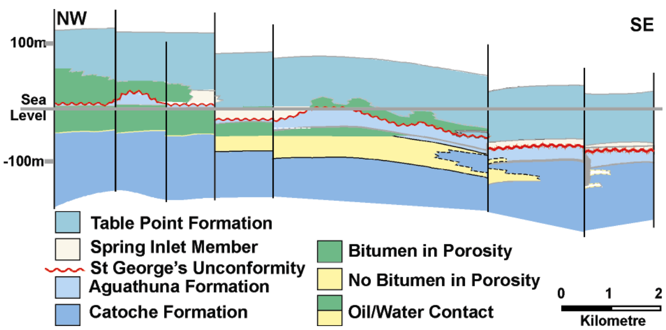


Fig. 23 Cross-section through the Ordovician carbonate platform in the Port aux Choix area. The platform is cut by a series of steeply dipping normal faults. A body of hydrothermally altered dolomite (porosity) is mappable across the entire area, in some cases spatially limited around the faults, but generally up to 10km wide (and extending an unknown distance off-shore), at least 8km long and up to 300m thick. Dolomite porosity is most extensive in the upper Catoche Formation, spottier in the peritidal Aguathuna and Spring Inlet Member, and extends as high as the lower Table Point Formation.

Acadian inversion of the Round Head Thrust. Maturity data from the Humber Arm Allochthon and the Carboniferous on the southern shore of Port au Port Bay indicates that the strata are in the oil window (Williams et al. 1998). This suggests that the Port au Port peninsula was covered by approximately 1-2 km of Carboniferous strata prior to (?) Mesozoic uplift and erosion.

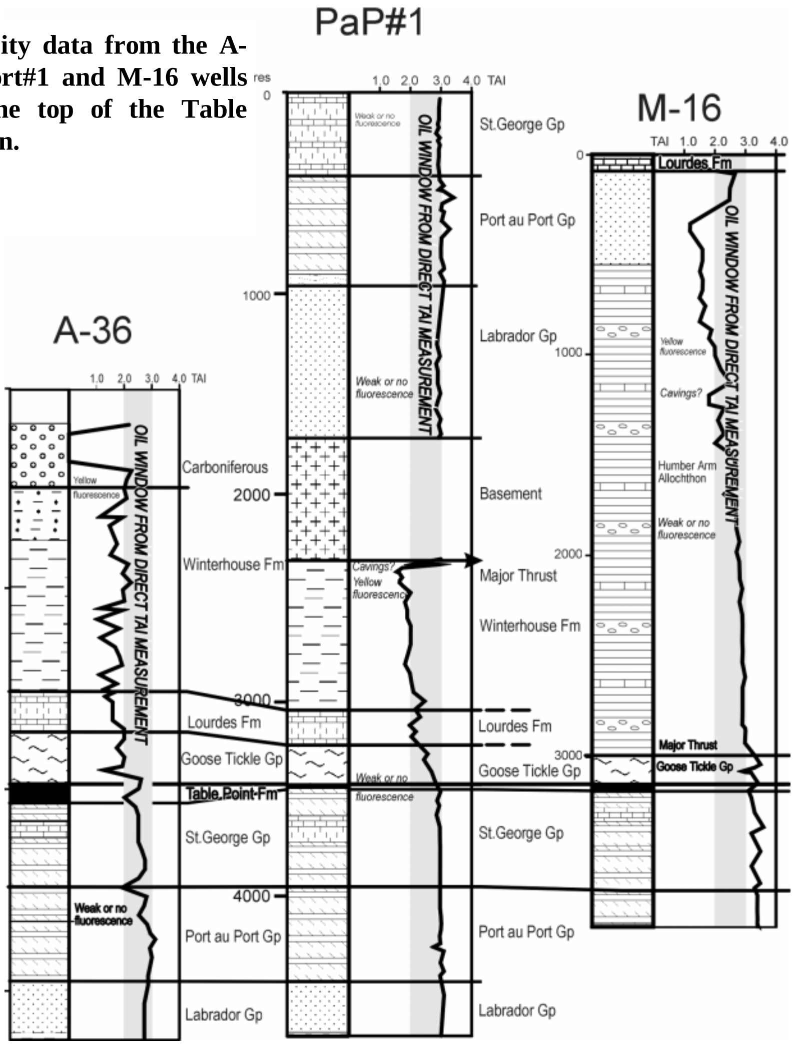
In the Port au Port #1 and A-36 wells the maturity data shows a sharp increase in maturity level through the Goose Tickle Group and into the top of the carbonate platform (Fig. 24). This could be interpreted as evidence for erosion of sediment at the Taconic unconformity but the maturity data show a smooth increase across the unconformity rather than a jump which would indicate erosion. The preferred model is that the increase in maturity is due changes in the thermal conductivity of the strata wherein the Goose Tickle Group acts as an aquiclude to the hydrothermal fluids trapping heat below (Fig. 25). The heat flux could only have been transmitted upwards by less efficient conduction creating a halo of elevated maturity in the Goose Tickle Group which quickly dissipated upwards.

The relative consistency of maturity levels in the St. George and Port au Port groups in the wells drilled and at outcrop strongly suggests that both the development of the triangle zone and the inversion of the Round Head Fault did not impose additional burial on these rocks. As tectonic burial was occurring syn-orogenic erosion must have removed uplifted strata to maintain a relatively consistent paleo-topography. The analysis of apatite fission track data (Stockmal et al. 1995a, Mukhopadhay 1997, Grist 1997) strongly indicates a period of exhumation that ended in the early Carboniferous, following the Acadian deformation. Most workers agree that there was burial of the area by 1-2 km of post-Viséan sediment subsequently removed by erosion (Mukhopadhay 1997, Grist 1997, Stockmal et al. 1995a). The proposed burial history (Fig. 26) is based on the data from the Long Point M-16 well (Burden and Williams, 1996) which penetrated the potential source rocks of the Humber Arm Allochthon. This model proposes a variable geothermal gradient separating pre-tectonic and syn-tectonic strata from post-tectonic crustal unloading and erosion (Fig.26). The allochthonous strata containing the source rocks entered the oil window during the late Devonian Acadian orogeny due to loading by the Foreland Basin megasequences and tectonic thickening during the development of the triangle zone. The tectonic loading effect was however partially offset by uplift and erosion of the foreland basin megasequences in the roof of the triangle zone (Fig. 26). The oil window extends from about 1 to 2km depth with peak generation occurring during the Acadian orogeny; slow uplift throughout the Mesozoic and Cenozoic terminated generation despite the fact that the source rocks are still today in the oil window.

CONCLUSIONS

The recent phase of exploration in the Humber Zone of Western Newfoundland has provided a number of insights into the hydrocarbon play system. The integration of well data with published information and surface outcrop studies has allowed the development of a sequence stratigraphic framework for the region. The early extensional history of the Round Head Fault is now constrained by data from the Port au Port #1 and A-36 wells and the seismic data from Port au Port Bay. The early extensional history of the fault is critical in the development of reservoir quality in the inherently low porosity and permeability rocks of the Cambro-Ordovician platform. The paleo-highs on the footwalls of the extensional faults were the foci of karst development in the Early Ordovician and later hydrothermal dolomitization during the Devonian. Both of these processes significantly enhanced the porosity and permeability of shallow subtidal grainstone lithofacies in the platform succession. The extensional history of the faults also provided a migration pathway for generated hydrocarbons by juxtaposing the source rocks of the Humber Arm Allochthon against the reservoir rocks of the platform.

Fig. 24. Maturity data from the A-36, Port au Port#1 and M-16 wells datumed on the top of the Table Point Formation.



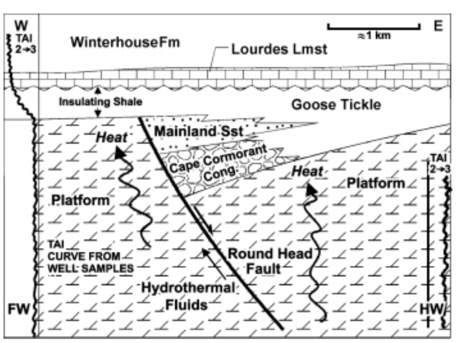


Fig. 25. Proposed model for observed thermal maturity patterns invoking the Goose Tickle Group as an aquitard and thermal barrier. FW, Port au Port #1 well footwall section; HW, Port au Port #1 well hangingwall section

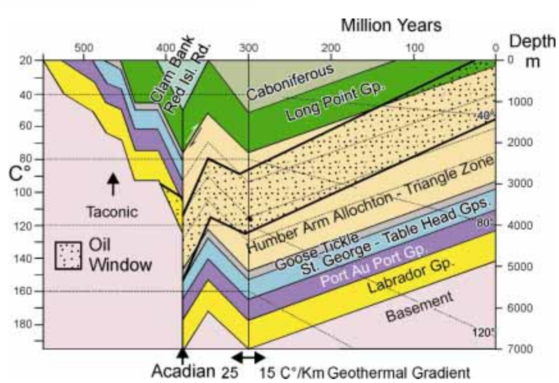


Fig. 26. Burial history plot for the Port au Port area based on the M-16 well showing likely timing of hydrocarbon migration.

Modelling of the thermal history of the source rocks suggests that they entered the oil window during the Late Ordovician as a result of deposition of the Taconic and Salinic Foreland Basin megasequences just prior to the onset of the Acadian orogeny and were still within the oil window during Acadian deformation. The inversion of the extensional faults during the Acadian orogeny created compressional footwall shortcut structures that have been the focus of exploration drilling to-date. Extensional faults that are located beyond the western limit of the Acadian compressional deformation may also be prospective exploration targets but this play remains untested. The play fairway of Acadian compressional structures extends as far north as Portland Pond. Further to the north the prospective reservoir sections are exposed at surface and hence any traps are breached. The future of successful exploration within the Humber Zone will depend on the application and modification of the play concepts presented within this paper; we believe that considerable potential remains in the play.

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