PRELIMINARY VERSION MAY 2000

CORE SEDIMENTOLOGY LOG

BOREHOLE 11/20-sb01

ENCLOSURE: 1

Petroleum Infrastructure Programme
Rockall Studies Group

For key refer to separate sheet

SCALE 1:40

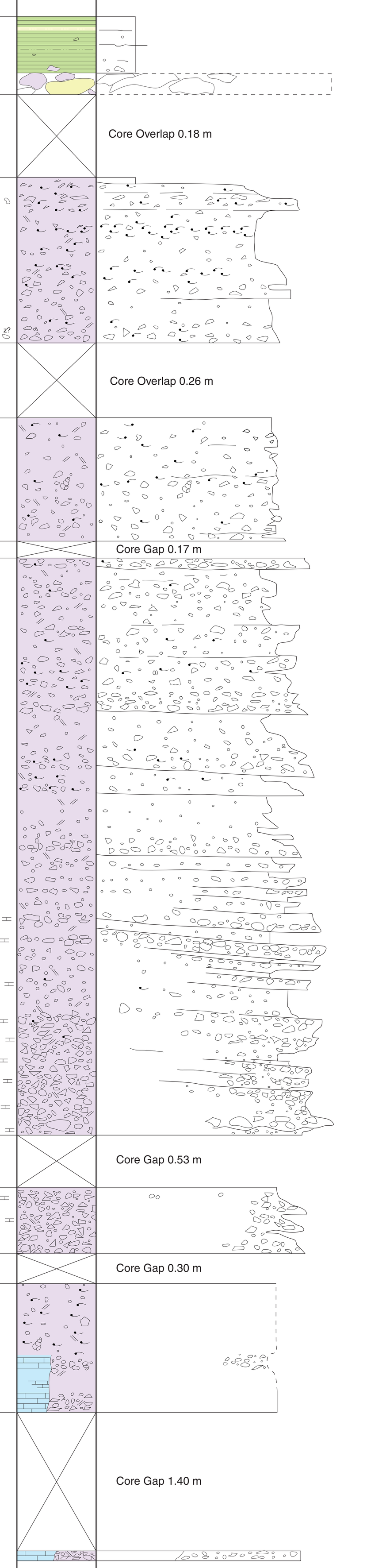
Marine & Petroleum Geology Group

RSG Project 97/28

Provisional Stratigraphy	Depth (m) from seabed	Core/Box No.	Colour	Cements	Project 97/28 Sample Nos.
Pliocene	7.22 – 8.00	1	10YR 4/2 to 5/2		13416, 13415
	8.00 – 7.82	Core Overlap 0.18 m			
Palaeocene?	7.82 – 9.50	2, 3	7.5YR 5/4	Ca, z?	13417, 13418, 13414
	9.50 – 9.24	Core Overlap 0.26 m			
Palaeocene?	9.24 – 10.50	4, 5	5Y 4/2	Ca	13413, 13412
	10.50 – 10.67	Core Gap 0.17 m			
Palaeocene?	10.67 – 16.50	5, 6, 7, 8, 9, 10, 11, 12	5Y 4/2; 10YR 6/6; 10YR 6/6; 5YR 5/6; 5YR 5/4		13411, 13410, 13409, 13408, 13407, 13406, 13405
	16.50 – 17.03	Core Gap 0.53 m			
Palaeocene?	17.03 – 17.70	12, 13	10YR 5/6	Ca	13404
	17.70 – 18.00	Core Gap 0.30 m			
Palaeocene?	18.00 – 19.30	14, 15	10YR 5/6		13403, 13402
	19.30 – 20.70	Core Gap 1.40 m			
Palaeocene?	20.70 – 20.80	15		Ca	13401

Columns: Provisional Stratigraphy; Samples; Depth (m) from seabed; Core/Box No.; Colour; Fractures; Cements; Lithology; Grain Size & Sedimentary Structures (Mudrock: Clay, 0.004 Silt; Sand: 0.062 Very Fine, 0.125 Fine, 0.250 Medium, 0.500 Coarse, 1.00 V. Coarse; Conglom.: 2.00 Granule, 4.00 Pebble, 64.0 Cobble); Trends; Project 97/28 Sample Nos.; Remarks; Lithofacies Summary & Depositional Environment

Depth scale: 7.22, 8.00, 7.82, 8.00, 9.00, 9.50, 9.00, 9.24, 10.0, 10.50, 10.67, 11.0, 12.0, 13.0, 14.0, 15.0, 16.0, 16.50, 17.0, 17.03, 17.70, 18.00, 19.0, 19.30, 20.0, 20.70, 20.80



Remarks

NOTE: Recovered core is placed at the base of each core run, following BGS practise.

- 13416 – soft, sticky, dark yellow brown clay with pebbles or nodules; occasional black sulphide streaks; disturbed.
- greenish 'tuff' pebble.
- 'milled' gravel with cobbles of underlying tuff (veined by carbonate), dark siltstone and a clean quartz sandstone.
- 13415
- 13417 – plastic brown clay.
- red-purple 'tinge'.
- lithic lapilli tuff, admixed shell fragments, patchy calcite/zeolite cement.
- 13418 – subvertical micritic limestone dyke with reddened margins and hairline lapilli-traversing offshoots.
- local open framework.
- 13414 – wide variety of vesicular, aphyric and sparingly porphyritic basaltic lapilli, some well rounded.
- range of lapilli types, up to 48mm across.
- several generations of micrite-filled fractures, the micrite containing fossils and locally tuff fragments. Fracture margins generally straight but locally embayed.
- 13413 – subvertical micrite intrusion/fracture fill, margins rich in entrained tuff fragments.
- sill-like injected offshoots from main micrite bodies.
- late calcite veins traversing micrite and exploiting carbonate intrusion margins.
- 13412
- network of subhorizontal micrite filled sills.
- well-rounded volcanic lithic fragments up to 25mm across; bedding sub-horizontal.
- some of lapilli encrusted by serpulids.
- rapid change in colour, strongly reddened below this level.
- 13411 – lapilli surrounded by dark 'palgonitised' rims.
- 13410
- clast-supported fabric; becoming increasingly reddened downwards.
- 13409
- crude inverse grading; bedding inclined at *c.*10 degrees.
- pebbles up to 40mm across; many rounded, open framework infilled by zeolite/calcite cement.
- 13408
- 13407 – upward change to alteration rimmed and more diverse lapilli compositions.
- inversely graded base
- 13406 – widespread development of open framework with pore-filling cements.
- 13405 – clast >80 mm across; ragged altered margin
- inverse grading
- 13404 – bedding not obvious
- lapilli up to 4 mm across
- 13403 – extensively slurried/poorly consolidated to base of box; rich in shell fragments, including echinoids
- more sandy?
- 13402 – grey calcareous cemented tuff adjacent to intrusive limestone
- broken recovery of lapilli tuff and intrusive pale brown micritic limestone with sub-vertical fabric
- 13401 – cross-cutting tan brown micritic limestone, hosted by clast-supported lapilli tuff with zeolite/calcite cement

Lithofacies Summary & Depositional Environment

7.22m

A short interval of soft, sticky, smectitic clay with scattered small pebbles, minor sand laminae and black sulphide streaks.

Interpretation: a clay-prone, slope-drape deposit (remobilised?), resting on a possible erosion surface. *7.75m*

A 'milled' collection of pebbles and cobbles, including blocks of the underlying lapilli tuff and an 'exotic' quartz sandstone block (the former probably a coring artifact).

Interpretation: although some of the clasts may be coring artifacts, the diversity of composition suggest a possible residual gravel resting on a slope erosion surface. *7.82m*

Clay-prone slope drape resting on erosion surface

An interval of well cemented, poorly sorted, crudely bedded, red-brown to green-brown, lapilli tuffs, with bedding picked out by subtle changes in grain size and several shelly coquina horizons. Bedding is sub-horizontal and traversed at a high angle by subvertical, biomicrite-filled veins and fracture fills. The tuffs are polymict, with highly vesicular red brown to dark grey lapilli, some of which are well rounded. Others have a dark alteration rim (palagonite?).

Interpretation: the lapilli tuffs are interpreted as marine reworked pyroclastic deposits which formed in high-energy, shallow water by reworking on the subaqueous slopes of a Surtseyan tuff cone. Marine re-working accounts for the variety of volcanic lithologies, the variable texture and the abundant shell material; rounded lapilli may have been stripped from beaches. The shell concentrations suggest deposition in relatively shallow water. The tuffs were cemented by zeolite and calcite, before fracturing and multi-phase intrusion by a soft micritic carbonate sediment (now limestone). The carbonate probably exploited fault-related fractures through which it was hydraulically pumped. The borehole is positioned close to a fault (possibly a gravity-induced structure) which downthrows both the lapilli tuff pile and an overlying seismically transparent unit to the west (not present in this borehole). The later may represent the carbonate sediment which was remobilised during faulting. *10.50m*

Marine reworked lapilli tuffs deposited subaqueously on unstable tuff cone apron, and later fractured and intruded by micrite

A locally well-stratified (particularly towards the base), poorly sorted package of 'reworked' lapilli tuffs and tuff breccias (c. 4.6m thick) comprising a range of generally highly vesicular basaltic fragments, some angular, some well rounded, together with mostly dispersed and broken bioclastic fragments (bivalve shells, corals, bryozoans), the whole cemented by calcite. This section is distinguished from the overlying deposits by the rarity of cross-cutting micrite veins, and it sits (with a transitional contact) on compositionally and texturally distinct lapilli breccias beneath. Bedding is locally evident in the form of sharp changes in grain size and is for the most part approximately horizontal, but low angle dips are apparent towards the base of the interval. Decimetre scale stratification also occurs low in the interval, but vertical trends are inconsistent. There are several normally graded intervals. Little porosity is retained, on account of extensive calcite cementation. Early palagonite and zeolite (phillipsite) grain rimming phases occur in better sorted, less bioclastic intervals.

Interpretation: the vesicularity and variety of the lapilli, together with the dispersed bioclastic fragments, indicates submarine deposition in an area close to a contemporary volcanic centre (tuff cone?), with both magmatic and possible hydrovolcanic fragmentation followed by marine reworking. There is little evidence for tractional currents and deposition on unstable subaqueous volcano slopes by gravity-driven flows seems likely. The lack of interbedded 'fines' (= background) suggests rapid, near continuous eruption-driven sedimentation, with fragmented volcanic material incorporated and mixed with a shallow-water shelly fauna derived from the littoral zone flanking the volcano. Where locally well-sorted, finer grained and more openly packed (e.g. 13.10-13.30m) and lacking bioclasts, this may represent local syn-eruption flushing in the form of air fall into water. *15.70m*

Marine reworked lapilli tuffs deposited subaqueously on unstable volcano slopes, with minor pyroclastic (?airfall) reflecting syn-eruption supply

Downward 'transition' into a distinctive 'monomict' but texturally variable, well sorted, crudely stratified (particularly upper section) lapilli tuffs, characterised by a very open framework and pervasive isopachous zeolite and pore-filling calcite cement. Individual lapilli are highly vesicular, sparingly porphyritic (altered olivine, plagioclase) and angular in shape. Apart from the transitional top to the unit, bioclasts are absent. Blocks locally are up to >80mm across. Vertical trends are poorly defined. A network of thin fossiliferous micrite fracture fills (sills) occurs at 17.25m and postdates both zeolite and later sparry calcite cement, locally spilling into remnant macroporosity.

Interpretation: the distinctive packing, texture, the lack of bioclasts and the monomict composition suggest a primary syn-eruption origin, probably by pyroclastic fall into water (the encasing tuffs contain marine fossils), followed by modest gravity-driven resedimentation. The good sorting and absence of ash are consistent with aeolian fractionation. The open fabric and palagonitised lapilli rims reflect subaqueous deposition. *17.70m*

Primary syn-eruption pyroclastic fall into water

A poorly consolidated section comprising a volcaniclastic 'sand' made up of broken lapilli fragments and clusters, cement pieces (palagonite-zeolite-calcite) and a variety of bioclasts and fossiliferous micrite grains.

Interpretation: this interval is analogous to the intact marine-reworked lapilli tuffs towards the top of the core, but here are poorly recovered due to breakage of the altered volcanic fragments. The section appears to have contained cross-cutting micrite veins (broken during coring). *18.75m*

Marine reworked pyroclastics

An incompletely cored section, intact pieces of which suggest a lapilli tuff breccia cross-cut by a subvertical fossiliferous micrite fracture fill. The recovered lapilli tuffs are well sorted, loosely packed, and cemented by isopachous zeolite on palagonitised grain rims followed by pore-filling calcite (local open vugs remain). Close to carbonate veins, micrite spills into remnant calcite filled pores, and forms a geopetal fill prior to sparry calcite cement (contrast with overlying interval where micrite veins post-date calcite in sample 13410).

Interpretation: although poorly recovered, the 'host' lapilli tuff resembles the section from 15.30-17.70m and is assigned an airfall origin into water, with subaqueous settling onto unstable submarine slopes flanking an active Surtseyan-type tuff cone. The cross-cutting limestone is related to hydraulic fracturing associated with faulting of brittle zeolite cemented tuffs and a ?cover of unconsolidated carbonate, with multiphase hydraulic pumping of soft carbonate mud into fault-related (tectonic or gravity-driven?) fracture systems. *20.80m*

Primary pyroclastic fall into water with later fracturing and carbonate injection

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This project, including data and survey results acquired for the purpose, has been undertaken on behalf of the Rockall Studies Group (RSG) of the Irish Petroleum Infrastructure Programme Group 2 which was established by the Petroleum Affairs Division of the Department of the Marine and Natural Resources on 4 June, 1997 in conjunction with the award of exploration licences under the Rockall Trough Frontier Licensing Round. The RSG comprises: Agip (UK) Ltd, Anadarko Ireland Company, ARCO Ireland Offshore Inc, BG Exploration & Production Ltd, B.P. Exploration Operating Company Ltd, British-Borneo International Ltd, Elf Petroleum Ireland B.V., Enterprise Oil plc, Mobil Oil North Sea Ltd, Murphy Ireland Offshore Ltd, Phillips Petroleum Exploration Ireland, Saga Petroleum Ireland Ltd, Shell EP Ireland B.V., Statoil Exploration (Ireland) Ltd, Total Oil Marine plc, Union Texas Petroleum Ltd, and the Petroleum Affairs Division of the Department of the Marine and Natural Resources.

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