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Contents

IAS Bureau and Council

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Super Sedimentological Exposures

The Ross Formation on Loop Head, SW County Clare, Ireland

Introduction

The Loop Head peninsula extends out into the Atlantic on the northern side of Shannon estuary in SW County Clare, western Ireland (Figure 1). A combination of the resistant, heavily quartz-cemented sandstones of the Carboniferous Ross Formation and the relentless pounding of the Atlantic waves have created a spectacular coastal shorescape with excellent cliff and foreshore exposures of the Ross, an instructive succession of deep-water turbidites. To the north, the Ross turbidites are overlain by slope and delta deposits, all three units forming the progradational fill (*c*.1500 m thick) to the Clare Basin.

The value of the Ross cliff exposures as a subsurface reservoir analogue was recognised over 20 years ago and since then the area has been used extensively for industry training. Many university trips also visit the area. Together with the overlying slope and deltaic deposits, SW Clare has also become an important location for illustrating the application of high-resolution sequence stratigraphic concepts in the field. In addition, there are world-class examples of a wide variety of soft-sediment deformation features. In recent years, the Clare Basin has become a test-bed for the application of much new technology (LIDAR, ground-penetrating radar, outcrop-gamma, photo-realistic mapping, seismic modelling) culminating in an SEPM meeting in June last year (2008) on 'Outcrops revitalized' based at Kilkee. Clare is shortly to be covered by a new IAS Field Guide, and earlier this year, the Loop was the site for two 'behind-outcrop' research boreholes, part of a pilot study aimed at augmenting the training resources available to geological visitors to Clare (Figure 2).

The brief comments below relate to the Loop area and the Ross Formation exposed there. However, visitors will almost certainly want to take in the overlying slope and delta deposits as well and the new IAS

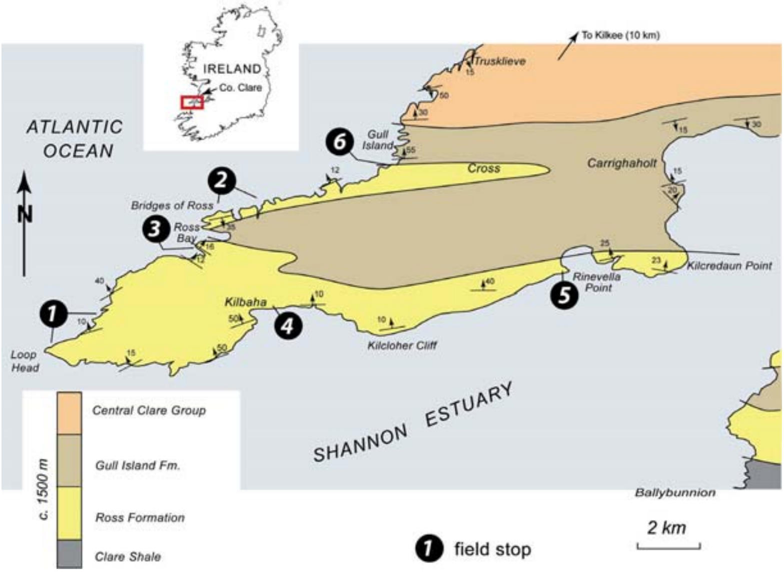

Figure 1. Location and outline geological map for Loop Head area, Co. Clare, with key Ross exposures and field stops indicated. After Martinsen et al. (2003) and Pyles (2008)

Field guide will be a very useful companion to both the Loop outcrops and those elsewhere in Clare. There is already an existing IAS field guide to many of the exposures arising from the IAS Regional Meeting in Dublin in 2000 (Elliot *et al.* 2000), and there is also a recent SEPM Field Guide (Martinsen *et al.* 2008). The coastal town of Kilkee is a convenient base for field parties and is only a little over an hours drive from Shannon airport and a half hour from the Loop. A range of hotels and B&B options are available in Kilkee, and there are also guest houses further out on the Loop. The best way to see some of the cliff sections is from the sea, and it may be worth taking a trip on the Dolphinwatch boat based out of Carrigaholt on the Shannon estuary. Larger field parties can hire the boat specifically for geology trips – captain Geoff Magee knows all the key cliff exposures and is adept at getting the boat close to the outcrops! A couple of shoreside pubs at Kilbaha on the south side of the Loop provide a useful 'comfort stop' and lunch option.

A word on safety - the sites to be visited are all coastal, on cliff top paths and platforms, and on rocky foreshores. Some sections face the Atlantic, others the Shannon estuary. Normal precautions for working on coastlines apply, but pay particular attention to wave conditions and bear in mind that 'rogue waves' can strike well above the level of the average wave. Low tide is required for stops 3 to 5. Also note that the fine grained sandstones can be extremely slippery when wet so watch your footing at all times. You

Figure 2. Behind-outcrop borehole 09-CE-UCD-01 drilling at Ross in March 2009, part of a collaborative project involving University College Dublin, StatoilHydro, Andy Pulham and Trevor Elliot and designed to augment the subsurface training experience available in Clare

will find the east-west trending spaced Variscan cleavage provides essential traction! Lastly, the west of Ireland is famous for its narrow and winding roads and the Loop is not exception so do take great care whilst driving.

Some geological background

The coastal exposures of south Co. Clare have been worked extensively since the 1950s are there is a rich literature, too extensive to detail or adequately reference here. Key publications deal with aspects of the biostratigraphy (Hodson, 1954), the soft-sediment deformation (Gill, 1979; Martinsen, 1989; Strachan, 2002), the sedimentology of the deep-water fan (Chapin *et al.* 1994; Elliot, 2000a,b; Lien *et al.* 2003; Martinsen *et al*. 2000; Pyles 2008), slope (Martinsen *et al*. 2003) and delta Pulham, 1989; Wignall & Best 2000) deposits and the sequence stratigraphy and surface expression (Davies & Elliot 1996). Despite, or perhaps because of the excellent coastal exposure, aspects of the story remain controversial or incompletely understood, but this adds spice to a visit to the exposures.

Regional crustal stretching in the Lower Carboniferous allowed a thick succession of limestones to first accumulate in the Clare Basin. These are particularly well exposed in the Burren area of north Co. Clare, with its well known karstic landscape and unique flora – also worth a visit if you have time. The succeeding clastic deposits fill a basin that inherited much of its geometry from this earlier phase of subsidence. Sediment supply was from major, possibly transcontinental river systems draining distant source areas

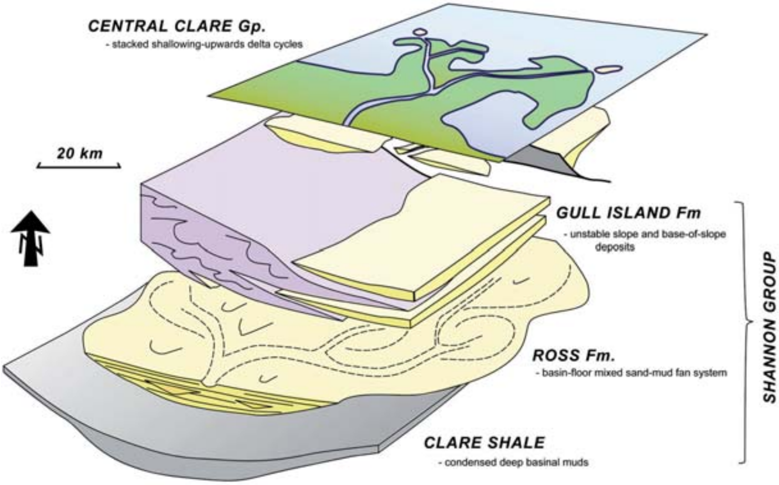

Figure 3. Cartoon illustrating the development of the Namurian Clare basin fill and the stratigraphic terminology

to the southwest, west and northwest. The rivers had a mixed load of clay, silt and sand grains, with little sediment coarser than medium sand. High sedimentation rates, the dominance of fine grained sediment and the draping of inherited slopes probably explains why evidence of slope instability is so widespread in the deposits. Analogies have been drawn with the modern Mississippi delta front.

The stratigraphic nomenclature for the Namurian basin fill was established by Rider (1974), building on earlier biostratigraphical work by Hodson (1954) and others. The succession is split into two groups, the older deep water/slope deposits (Shannon Group) and the overlying delta deposits (the Central Clare Group). The switch from carbonate production to clastic supply was followed first by a blanket of fine grained black shale deposits (the Clare Shale Formation) reflecting an initial period of sediment starvation. The area centred on the Shannon estuary was then the focus of deep-water sandstone deposition (the Ross Formation), whilst the North Clare remained starved of sediment and continued to accumulate a condensed blanket of phosphate and black shale. The Ross 'turbidites' are overlain by a thick succession of slope deposits (the Gull Island Formation) and then by shallow-water delta deposits of the Central Clare Group.

Marine faunas are largely restricted to thin 'marine bands'. These are stratigraphically important because they allow the succession to be split up and correlated at a resolution that is rarely attained elsewhere in the stratigraphic record. The marine bands are also laterally extensive allowing long-range correlations. It is estimated that marine bands, each with their own distinctive fauna, recurred every *c*. 65,000 -100,000 years and they are attributed to glacio-eustatic fluctuations in sea level in what was an 'icehouse' world.

Ross Formation

The Ross Formation is thickest in SW Clare (*c*. 400 m) and thins towards the north, east and south. It is primarily composed of sandstones (*c*.65% at Loop Head; Chapin *et al*. 1994), with subordinate interbedded shales and slumped horizons. The sandstones are mostly fine to very fine grained, in dm-scale beds, many of which have sheet geometry. Interbedded slumped and disturbed horizons, and laterally discontinuous channelised units are more common towards the top of the formation. The base of the formation is seen at Ballybunnion, on the south side of the Shannon estuary (Figure 1), and it is marked by a gradual increase in the thickness and abundance of sandstone sheets in black shales. A number of laterally extensive 'marine bands' are seen within the formation; Elliot (*pers comm*.) has recognised at least nine condensed sections in the Ross, only three of which have been biostratigraphically typed. The sandstone beds are interpreted as a turbidites dispersed from an unseen source lying to the southwest, and blanketing the deepest part of the basin floor as a fan or partly confined sheet system (Figure 3). The Ross Sandstone Formation is transitional with the overlying Gull Island Formation, with the boundary placed at the widespread *Reticuloceras paucicrenulatum* marine band.

Detailed architectural analysis of the Ross exposures has identified a number of building blocks or elements (Figure 4). Sandy sheet elements dominate and are either disorganised or packaged in crude upward-thickening 'cycles' up to 7 m thick. Slump horizons tend to form mud-prone sheet elements, the thicker ones with km lateral extent. Ross channel fills tend to be sand-prone and dominated by amalgamated structureless and locally stratified sandstones, with mud-clast conglomerates draping basal erosion surfaces. Some channel fills show evidence for lateral migration and preserve lateral accretion packages (LAPs). An interesting feature of the Ross is that channel relief was relatively low (generally <10 m) and the channels were prone to fill to spill, forming sandy wing elements extending laterally from the channel bodies. Another intriguing feature of the Ross is the presence of prominent erosion surfaces apparently associated with bypass (megaflute erosion surfaces of Elliot, 2000a). These surfaces are distinguished by fields of megaflutes, scours and bedforms and they are generally draped by thin mud-prone intervals (repair facies of Elliot 2000a,b) suggesting whatever cut the surfaces was followed by a period when the main sand-bearing flows were diverted elsewhere. The final architectural element is the condensed section, distinctive fine-grained shales with discrete goniotite-bearing horizons that are thought to represent a temporary shutdown in sand supply as periods of rising sea level sequestered sand in shallow-water depocentres.

Some critical issues continue to be debated in the Ross and the on-going outcrop characterisation and new subsurface work will hopefully shed further light on these:

- The relationship of the Ross turbidite system and the

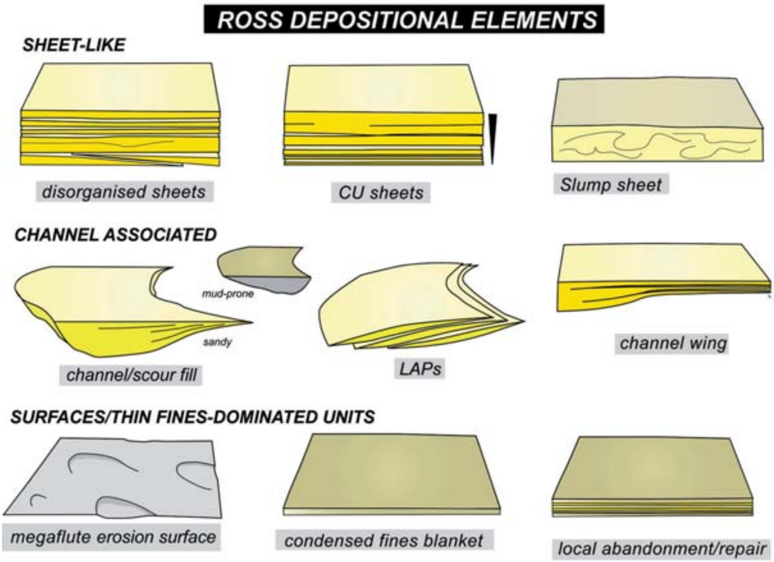

Figure 4. Summary of deep-water architectural elements present in the Ross Formation, Co. Clare

overlying Gull Island slope system – a north-easterly stepping slope to basin floor profile or interfingering of axial turbidites and a lateral eastward- or southeast-facing slope system?

- The nature of the lateral and down-dip margins of the deep-water system – ponded minibasin, lateral slope confinement or down-dip pinchout?
- The significance of the megaflute erosion surfaces – single bypassing flows, flow spillout from channels or channel-lobe transition zone processes?
- The mix of flow processes – conventional turbidites and hybrid event beds (Haughton *et al*. 2009) occur in the Ross but what is this telling us?
- Correlation at km length scales – significant uncertainty remains as to how to tie the different outcrops across the Loop.

Field localities

The following field localities serve to illustrate (1) the main architectural elements of which the Ross is composed (2) element stacking patterns and (3) vertical changes in the character of the succession and the higher frequency response to icehouse forcing. Allow at least 1.5 to 2 days to do justice to the exposures. Grid references cited below are the Irish National Grid. Ordinance Survey Ireland Discovery Series Map No. 63 (1:50,000) is useful for navigation.

Figure 5. View of cliffs (40 m high) on the north side of Loop Head illustrating the predominantly sheet-like architecture of the mid-Ross succession here. Note the Variscan fold hinge on the left and the candidate condensed section (arrowed)

Stop 1: Loop Head *(Q 692 472)*.

The high (40m) sea cliffs at Loop Head are a useful starting point. These illustrate the character of the lower-mid Ross Formation, and represent some of the oldest part of the succession exposed on the Loop. Drive to the end of the Loop using the R487 via Kilbaha and park at the lighthouse. From here, walk north to the cliff edge and work both northeast as far as Gull Island (Q 702 482 – note not the type section for the Gull Island Fm!), and to the west as far as tip of the Loop (Q 686 472). The southwest side of a rocky promontory at Bullaunnleama (Q 697 478; Figure 5) shows bedding gently dipping north with stacked laterally extensive sandstone beds producing a strongly sheet-like architecture – mainly disorganised sheets with some putative upward-thickening cycles. Note the absence of slumping. Sandstones beds locally amalgamate vertically and a prominent thin dark mudstone half way down the cliff represents a candidate condensed section. The succession here is thought to represent mid fan deposition down-dip from distributary fan channels. Further along the cliffs at Gull Island, amalgamated sandstones cap upward-thickening cycles and have sharp erosional tops with scoop-shaped (possibly megaflutes in cross-section) and undulose erosive features (Figure 6). Returning to the west, the side of Dermot and Grania's Rock (Q 686 473) shows evidence for lateral conmpensation of sandstones, possible megaflutes in cross-section again, and another thin condensed section. One of the main things to take away from these outcrops is that despite the mid fan

Figure 6. Gull Island north of Loop Head (Stop 1) showing sharp erosive 'tops' to sandbodies (arrowed) and predominantly sheet-like bed architecture

location and lack of evidence for channels, erosion is still important in shaping the tops of the sandier sections – this is non-intuitive in that normally it is erosion at the base of amalgamated sandstones that is important.

Stop 2: Bridges of Ross:

This is a very important locality for understanding the nature of the upper Ross Fm. The same level in the upper Ross can be followed along the coast here for almost five kilometres slightly oblique to the general SW to NE sand transport direction. The locality is famous of course for the Bridges or to be more accurate 'the Bridge' as only one remains. This is a very beautiful sea arch formed by recent coastal erosion of the core of an E-W trending Variscan anticline. Off-road parking is available at Ross (Q 735 504). If time permits it is worth traversing both west and east of the car park. To the west, the remaining bridge is found, and wrapping over it, the Ross Slump (Figure 7). This is a mud-prone slump unit approximately 8 m thick which has been described in detail by Strachan (2002) -essential reading if you are to visit this locality. The slump is overlain by a pair of upward-thickening sheet units, and then by a channel complex involving at least three erosionally-based channel fills. The latter are typical of the sand-prone, relatively shallow Ross channels and are described by Lien *et al.* (2003). Overall the section is taken as a more proximal fan section than that seen deeper in the stratigraphy at Loop Head (Stop 1) and consistent with an overall progradational signature for the Ross.

Another reason this locality is famous is because of the sand volcanoes that occur on top of the Ross Slump (Figure 8). Sand masses liquefied within the moving slump

Figure 7. The Ross Slump (grey unit in centre) overlain by sheet and channel elements at Bridges of Ross (Stop 2)

erupted to the slump surface as it arrested, producing spectacular sand volcanoes up to several metres in diameter and displaying a range of morphologies. These are best seen on the headland to the east of the car park (Q 736 506). The Ross Slump and overlying sheet and channel complex (and indeed the sand volcanoes) can be followed along the cliff tops to Fisherman's Point and beyond. Details of the channels at Fisherman's Point are provided in Lien *et al*. (2003) and a

Figure 8. Spectacular sand volcanoes on top of the Ross Slump, east of the Bridges of Ross

Figure 9. Large megaflute south of Ross Bay (Stop 3). Note hammer for scale

correlation panel along the coast by Martinsen *et al*. (2000).

Stop 3: Ross Bay South (Q 727 497):

The section lies just to the south of the Bridges of Ross on the southern limb of a syncline that returns the upper Ross to the surface (Figure 1). Park at the gravel beach at Q 733 498 and walk out along the shoreline to the northwest. At the headland, there is an excellent 3D exposure of a megaflute erosion surface similar to those inferred in the 2D cliff sections at Stop 1 (Figure 9). This exposure has featured in publications by Elliot (2000b) and Lien *et al.* (2003), both of which have a different take on it. A critical point is the timing of the megaflute erosion relative to the ripples found on the top of sandstone bed into which it is incised, and what (if any) component of the megaflute fill can be attributed to the flow which cut the megaflute – did the flow completely bypass this location? Additional megaflutes and their typically fine-grained fills are also well exposed in the vicinity.

Stop 4 Kilbaha Bay (Q744 482):

This locality provides laterally extensive foreshore exposures facing the Shannon estuary. At low tide, the mid Ross can be followed along strike parallel to the coast for almost 2 km. Many groups (starting with Chapin *et al.* 1994) have undertaken detailed logging and bed correlation exercises at Kilbaha (see also Elliot 2000b, Sullivan *et al.* 2000, Martinsen *et al.* 2003, Lien et al. 2003 for published examples). These panels provide very useful context when walking the section.

The outcrop is at a high oblique angle to the palaeocurrent which is towards the NNE. A west-to-east traverse reveals a pair of shallow mid-fan channels connected to lateral extensive wings when followed eastwards. The western channel has an interesting basal mud-clast conglomerate and evidence for open-channel flow transmission. The eastern channel demonstrates lateral

Figure 10. Hybrid event beds with clean sand lower portion (paler) and clay-rich sand upper divisions (darker) dominating a thin-bedded interval at Kilbaha Bay (Stop 4)

transition from amalgamated sandy fill to sandstones separated by mud-draped erosion surfaces and bed tops. There are also numerous laterally extensive erosion surfaces decorated with megaflutes in the more sheet-like sections lateral to the channels. Upward thickening cycles are also well developed and this is a good place to debate their origin *viz a viz* channel overbanking, channel fill to spill, or channel-lobe transition processes related to up-dip channels. An important constraint is the nature of the thin-bedded sandstones at the base of the cycles. Whilst some are thin bedded rippled and lamainted sandstones (low-densiy turbidites), other thin bedded packages are dominated by mud-clast and clay-rich hybrid event beds (turbulence suppressed flows) that must have a different origin (Figure 10; see Haughton *et al*. 2009).

Stop 5 Rinevella Point (Q 819 490):

Rinevella Point can be accessed from the western side of Rinevella Bay. This south-east facing tidal exposure just west of the bay provides a good opportunity to examine a deeper Ross channel complex in cross-section. A description of the channel is provided by Sullivan *et al*. (2000) and is reproduced in Martinsen *et al*. (2008). Two laterally offset channels are preserved in oblique section – these are up to 15 m deep and 400 m wide. The western channel shows marked bed thinning and convergent geometry in the thin-bedded channel margin facies (Figure 11). Both channels show an element of lateral accretion suggesting some sinuosity.

Stop 6: Gull Island South near Cross (Q 774 517):

This stop provides an opportunity to examine the upward transition from the Ross into the overlying Gull Island Formation, and to examine a well-exposed section through one of the condensed sections – this one in fact a doublet containing the *R. paucicrenulatum* and *R. dubium*

Figure 11. View looking east standing on thin-bedded channel margin facies looking towards the thicker bedded, more amalgamated fill in the axis of the western Rinevella channel

marine bands. Park at the shale quarry at Q 780 525 and walk southwards along the top of the cliffs until the general strike of the coastline swings SSW. Here the condensed section can be examined in a gully. About two metres of dark mudstone with thin goniotite-rich

Figure 12. Recessively-weathered condensed section at the top of the Ross sandstone, near Cross (Stop 6)

horizons marking the marine bands occur sandwiched with sandy turbidite beds (Figure 12). This is also a good locality to examine the multiple levels of slope deformation affecting the upper Ross and the upward increase in the extent of gravity-driven deformation spanning the transition between the Ross and the Gull Island formations. A key question here is the geometry of the slope driving deformation – was it linked to turbidite progradation and facing NE, or is it a case of basin floor turbidites interacting with an unstable lateral SE facing slope?

Selected References

Chapin, M.A., Davies, P., Gibson, J.L. & Pettingill, H.S. (1994). Reservoir architecture of turbidite sheet sandstones in laterally extensive outcrops, Ross Formation, western Ireland. In Weimer, P., Bouma, A.H. & Perkins, R.F (eds), *Submarine fans and turbidite systems*, GCSSEPM Foundation 15th Annual Research Conference, 53-68.

Collinson, J.D., Martinsen, O. Bakken, B. and Kloster, A. (1991). Early fill of the western Irish Namurian Basin: a complex relationship between turbidites and deltas. *Basin Research*, **3**, 223-242.

Davies, S.J. & Elliott, T. (1996). Spectral gamma ray characterisation of high resolution sequence stratigraphy: examples from Upper Carboniferous fluvio-deltaic systems, Co. Clare, Ireland. In Howell, J.A. & Aitken, J.F. (eds) *High resolution sequence stratigraphy: innovations and applications.* Special Publication of the Geological Society London, 104, 25-35.

Elliott, T., (2000a). Depositional architecture of a sand-rich, channelized turbidite system: the upper Carboniferous Ross Sandstone Formation, western Ireland, P. Weimer, R. M. Slatt, J. Coleman, N. C. Rossen, H. Nelson, A. H. Bouma, M. J. Styzen, and D. T. Lawrence, eds., *Deep-water reservoirs of the world*: GCS-SEPM, p. 342-373.

Elliot, T. (2000b). Megaflute erosion surfaces and the initiation of turbidite channels. *Geology*, 28, 119–122.

Elliot, T., Pulham, A.J. & Davies, S.J. (2000). Sedimentology, sequence stratigraphy and spectral gamma ray expression of turbidite, slope and deltaic depositional systems in an Upper Carboniferous basin-fill succession, western Ireland. In Graham, J.R. & Ryan, A. (eds) IAS Dublin 2000 Field Trip Guidebook, 1-40.

Gill, W.D. (1979). Syndepositional sliding and slumping in the West Clare Namurian Basin, Ireland. *Geological Survey of Ireland Special Paper* **4**, 31pp.

Haughton, P, Davis, C. McCaffrey, W. & Barker, S. (2009). Hybrid sediment gravity flow deposits – Classification, origin and significance. *Marine and Petroleum Geology*, (in press).

Hodson, F. (1954). The beds above the Carboniferous limestone in County Clare, Ireland. *Quarterly Journal of the Geological Society of London*, 113, 441-460.

Lien, T, Walker, R.G & Martinsen, O.J. (2003). Turbidites in the Upper Carboniferous Ross Formation, western Ireland: reconstruction of a channel and spillover system. *Sedimentology*, 50, 113-148.

Martinsen, O.J. (1989). Styles of soft sediment deformation on a Namurian (Carboniferous) delta slope, western Ireland Namurian Basin, Ireland. In Whatley, M.K.G. & Pickering, K.T. (eds) *Deltas: sites and traps for fossil fuels*, Geological Society Special Publication, 41, 167-177.

Martinsen, O. J., Lien, T. & Walker R. G. (2000). Upper Carboniferous deep water sediments, western Ireland: analogues for passive margin turbidite plays, in P.

Weimer, R. M. Slatt, J. Coleman, N. C. Rossen, H. Nelson, A. H. Bouma, M. J. Styzen, and D. T. Lawrence, eds., *Deep-water reservoirs of the world*, Gulf Coast Section-SEPM Special Publication, p. 533-555.

Martinsen, O. J., T. Lien, Walker R. G. & Collinson, J. D. (2003). Facies and sequential organization of a mudstone-dominated slope and basin floor succession: the Gull Island Formation, Shannon basin, western Ireland. *Marine and Petroleum Geology*, 20, p. 789-807.

Martinsen, O., Sullivan, M., Pulham, A., Haughton, P., Harper, H. & Elliot, T (2008). Outcrops Revitalized: Tools, Techniques and applications – Field guide. SEPM Kilkee Research Meeting, June 22-27th 2008.

Pulham, A.J. (1989). Controls on internal structure and architecture of sandstone bodies within Upper Carboniferous fluvial-dominated deltas, County Clare, western Ireland. In Whatley, M.K.G. & Pickering, K.T. (eds) *Deltas: sites and traps for fossil fuels*, Geological Society Special Publication, 41, 179-203.

Pyles, D. R. (2008). Multiscale stratigraphic analysis of a structurally-confined submarine fan: Carboniferous Ross Sandstone, western Ireland. AAPG Bulletin, 92, 557-587.

Rider, M.H. (1974). The Namurian of West County Clare. *Proceedings of the Royal Irish Academy*, 74B, 125-142.

Strachan, L.J. (2002). Slump-initiated and controlled syndepositional sandstone remobilisation: an example from the Namurian of Co. Clare, Ireland. *Sedimentology*, 49, 25-42.

Sulliven, M, Jensen, G, Goulding, F., Jennette, D., Foreman, l. & Stern, D. (2000). Architectural analysis of deep-water outcrops: implications for exploration and devlopment of the Diana sub-basin, western Gulf of Mexico. In P. Weimer, R. M. Slatt, J. Coleman, N. C. Rossen, H. Nelson, A. H. Bouma, M. J. Styzen, and D. T. Lawrence, eds., *Deep-water reservoirs of the world*, Gulf Coast Section-SEPM Special Publication, p. 1010-1031.

Wignall, P.B. and Best, J.L. (2000). The Western Irish Namurian Basin reassessed. *Basin Research* 12, 59-78.

Report

IAVCEI – IAS 3rd International Maar Conference

Malargüe, Argentina, 14-17 April, 2009

Argentina was the host country in this year for the 3rd International Maar Conference in April. The original idea to organise a major scientific, multidisciplinary event on researches focusing on understanding maar volcanism and its consequences was born in Germany where the First International Maar Conference (1IMC) was organised in 2000. The meeting in that time had a great response from participants, and the idea kept up further in 2004, organising the 2nd International Maar Conference (2IMC) in Hungary. While the first meeting was locally supported, in the second meeting both the International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI) and the International Association of Sedimentologists (IAS) were involved as major supporting and scientific background of the meeting. While the first conference was held in the type locality of maar volcanism in Germany, in the Vulkaneifel Mountain concentrating on young maars, the second conference shifted the focus to the deep zones (diatremes) of maar volcanoes and brought the participants to a region in Central Europe where deep root zones of maar volcanoes are exposed. As a consequence of the 2IMC, a huge demand was to organise the 3rd International Maar Conference.

Due to many unforeseen events, the organisation has been started only in year 2006, having a location to be selected in Argentina. The 3IMC was held in a small desert town, Malargüe, in the foothill of the Andes in Mendoza Province of Argentina, April 2009 (Figure 1). The main theme of the conference was around the understanding of the role of phreatomagmatism in the evolution of volcanic fields. This theme was pre-determined by the location of the conference, nearby major back-arc monogenetic volcanic fields: the Llancanello and Payunia Volcanic Fields (Figure 2). These two volcanic

Figure 1. Opening ceremony of the 3IMC hosted in Malargüe

fields host more than 800 volcanoes with superbly preserved architecture. The majority of these volcanoes are scoria cones, but interestingly few of them represent tuff rings and tuff cones (Figure 3). These tuff rings and tuff cones clearly demonstrate that even in a volcanic field dominated by scoria cones (formed by magmatic fragmentation triggered eruptions) magma and water interaction-triggered eruptions can take place, and form their typical landforms of tuff rings and/or tuff cones. The questions of why and how perhaps the frontline subjects of scientific works today on volcanic fields, and the location in Argentina perfectly set the tone of the 3IMC. As a result, the submitted presentations represented a huge array of researches tackling these questions today.

The conference presented four significant plenary lectures. Prof. Volker Lorenz (Würzburg) presented a talk entitled «*The maar-diatreme volcano: the peculiar volcano type that largely prefers to work underground*». In his presentation, Prof. Lorenz summarized his experiences on maar-diatreme volcanism from a physical volcanology point of view, and made an excellent summary pointing out major research directions we may need to follow in the coming years such as understanding the diatreme formation, role of phreatomagmatism in composite volcanoes, and link between kimberlite volcanism and normal basaltic monogenetic volcanism. Dr. Guido Giordano (Rome) gave another very valuable plenary talk on «*The hydrogeological conditions to maar formation*». This presentation included a very important message to bring together hidrogeologists, hydrologists, sedimentologists and volcanologists to understand how phreatomagmatism and maar formation take place in continental settings. As water exists in the majority of sedimentary basins in continental settings, the understanding of the behaviour of this water in regard to its movement, recharge, and depletion processes would hugely advance our knowledge on magma and water interaction. Dr. Giordano highlighted many facts on the magma rheology, migration, rise and fragmentation that need to be

Figure 2. Overview of the cone fields of the Llancanello Volcanic Field with the pre-conference field trip participants on the top of Carapacho tuff ring

reconsidered to see clearly the feasibility of magma and water interactions in various «real world» crustal scenarios. He suggested that during the next maar conference, the hydrogeological aspects of phreatomagmatism may be the major focus. A plenary lecture gave a very comprehensive overview of the back arc monogenetic volcanism in Mendoza, and Northern Patagonia, presented by Prof. Victor Ramos (Buenos Aires). His presentation «*Payenia Volcanic Province: an exceptional Quaternary tectonic setting*» was a very fortunate lecture for the audience to help them to understand why monogenetic volcanic fields exist hundreds of kilometres behind the active subduction front, ranging in few millions of years ages to present day, very young eruptions. This lecture provided a good overview and supplement to the two field trip run to this nearby volcanic fields. Prof. Greg Valentine (Buffalo) presentation entitled as «*Processes and problems in intraplate volcanic fields - Source to eruption, and hazards*», gave a complete framework to the conference to highlight the major researches completed lately, and what need to be done in the near future to develop our understanding of monogenetic volcanic field evolution. His presentation concentrated on the deep processes and the shallow manifestation (e.g. time and space distribution of volcanoes) of those. He highlighted the need to make more detailed and complex, well-targeted studies on monogenetic volcanoes of any type including volcanic petrology, sedimentology, modelling, and geomorphological works on small-volume volcanoes. According to him such combined effort on small-volume volcanoes can pick up signatures maybe possible to amalgamate into a general model.

The 3IMC finally had 78 presentations submitted and published in the conference volume as an extended abstract (*Abstracts of the 3rd International Maar Conference, Malargüe-Argentina April 14-17, 2009, Asociación Geológica Argentina Publicaciones Especiales – Resúmenes y Eventos Serie D Nº 12 ISSN 0328-2767, Edited by Miguel J*

Figure 3. The Carapacho tuff ring visited by the participants during the intra-congress field trips

Haller and Gabriela I Massaferro, pp. 1-145). Due to the global economy crisis the total number of registered participants was lower than expected, but the organising committee was able to manage the conference to run smoothly with a very exciting scientific and social program. The conference was also an event supported by the IAVCEI Commission on Volcanogenic Sediments (CVS). This IAVCEI commission in the past years tried to find link between the volcanologist and sedimentologist communities. To do this, arranged conferences in the past attracted both volcanologist and sedimentologist experts. This effort was manifested in the dual involvement of two major organisations (IAVCEI and IAS) in the IAVCEI CVS activities in the past and in the 3IMC events. Very recent result of this gradually improving relationship is the current publication of a Special Issue in the Sedimentary Geology (Source to sink: volcaniclastic sedimentation in and around the Pacific) as a direct outcome of the volcanosedimentary technical session during the International Association of Sedimentologist World Congress in Fukuoka in 2006. The 3IMC gradually became part of the events could attract sedimentologists. The reason for this is that maar volcanoes are small, but very complex and important features in sedimentological point of view. The deep basins maar volcanoes generally have are the perfect sites to trap sediments in continental settings. In this way, maar lake sediments are in many cases provide the most complete section of a narrow time window, what and how terrestrial sedimentation was going on in specific areas. Since maar volcanoes exist in almost every climatic regimes, in every continent and every latitude, by now the research on maar lake sediments became a major study area where we can expand our understanding of past sedimentary basin evolutions and climatic effects. The IAS was an important partner in the success of the 3IMC, and certainly its role will increase in future events. This is especially expected in a way, that the International Maar Conferences in the future will be rather major events

Figure 4. Potrok Aike Maar, the location of the PASADO ICDP project in southern Argentina

in respect of understanding volcanic field formations, evolutions and from sedimentologist perspective, their potential influence on sedimentary basin evolutions.

During the 3IMC there were many very important presentations the sedimentological community would be interested in. Argentina as a host country for the 3IMC was(is) also the host of one of the very recent International Continental Drilling Projects, called the PASADO, aiming to understand the crater lakes accumulated in the Potrok Aike Maar lake in the Pali Aike Volcanic Field, in Santa Cruz Province in southern Argentina. Prof Bernd Zolitschka (Bremen) and his co-workers presented a very detailed update on the major outcomes of the Potrok Aike maar drillings (Figure 4). While this project was primarily planed work on the maar lake sediments, some off-spring researches targeted the primary pyroclastic successions accumulated around maar lakes in the Pali Aike Volcanic Field. Researches lead by Dr. Pierre-Simon Ross (Quebec), Prof Miguel Haller (Puerto Madryn), Dr. Hugo Corbella (Buenos Aires) and Dr. Karoly Nemeth (Palmerston North) demonstrated that the broad maars with shallow maar basins formed in the combination of the influence of strikingly different aquifers the rising magma encountered and being involved in phreatomagmatic explosions. The 3IMC also welcomed the first Chinese presenters in the maar conference histories. Prof. Chu (Beijing) presentation on the maar lake sediments in the Longgang Volcanic Field, China as well as Prof. Liu (Beijing) talk on the paleoclimate studies on maar lake sediments of the Aershan-Chaihe Volcanic Field in East Inn Mongolia, China showed the emerging research fields in Asia, and its huge future potentials via collaborative works among sedimentologists and volcanologists. As a representation of such collaboration Prof. Mingram (Potsdam) and his co-workers presentation on the potential of correlating chronomarkers in varved maar lake sediments is again confirmed that study of maar lake sediments is a powerful tool to understand climatic variations and

Figure 5. Prof. Roberto Sulpizio (Bari) awarded by the first Jim Luhr Award as the best presentation during the 3IMC

changes. Other presentations of the 3IMC focused more on the primary processes. The formation of base surges, pyroclastic density currents and associated syn- and post-volcanic secondary sedimentary processes in association with maar and other phreatomagmatic volcanoes is relatively well understood, but the diverse case studies certainly provided an important snapshot what, where and how others doing in these days in the global map. Large scale analogue experiments in combination with subsequent numerical modelling presented by Dr. Sulpizio (Bari) gave a very new research direction on pyroclastic density current formations. With this presentation Dr. Sulpizio and his co-workers were granted by the Jim Luhr Award funded by the 3IMC as a major award given to research presentations during the International Maar Conference event (Figure 5).

Overall the quality of the presentations was high, and many new research directions became evident for the participants. There is an unquestionable tendency of dramatic increase in the number of publications associated with monogenetic volcanism, many of them centred by the multidisciplinary researches on maar volcanoes in the past ten years. This tendency is marked by the year 2000 by the First International Maar Conference. By now, having the 3IMC completed, it is sure that this tendency will further develop. A multidisciplinary research volume as a Special Issue for a major international specialist journal will be edited by Prof. Miguel Haller and Dr. Karoly Nemeth. In the end of the 3IMC, the participants, in accordance with the given bids, have decided to have the Fourth International Maar Conference: as an interdisciplinary congress on monogenetic volcanism (4IMC) in 5-12 February 2012, in Auckland, New Zealand. The 3IMC has also been the special event, where the newly formed IAVCEI commission, the Commission on Monogenetic Volcanism, was announced officially by the President of the IAVCEI, Prof. Setsuya Nakada.

Overall, in the maar conference movement, it is a community need maintaining good and balanced relationship with IAVCEI and IAS.

Figure 6. Group photo of the 3IMC participants in Payunia during the intra-congress field trip

We hope that the majority of the 3IMC participants (Figure 6) will be able to join to the 4IMC in Auckland, and many new faces will bring their researches on this peculiar type of volcanoes, maars and associated features. The 4IMC hopes the IAS support can be sustained in the future. As the previous IMC event showed, it is worth to have such close link between volcanologists and sedimentologist.

Publications of the 3IMC

Haller, Miguel, J., Massaferro, Gabriela, I. (Editors), 2009. Abstracts of the 3rd International Maar Conference, Malargüe-Argentina April 14-17, 2009, Asociación Geológica Argentina Publicaciones Especiales – Resúmenes y Eventos Serie D Nº 12 ISSN 0328-2767, by, pp. 1-145

Risso, C., Németh, K., Nullo, F., 2009. Field Guide Payún Matru and Llancanelo Volcanics Fields, Malargüe - Mendoza. 3IMC. 3º International Maar Conference, April 14 - 17, 2009. [Guía de Campo a los campos volcánicos de Payún Matru y Llancanelo, Malargüe-Mendoza 3IMC. 3º Conferencia Internacional sobre Maares], 14 –17 April, 2009, Malargüe, Argentina. pp. 1-28. [in English and Spanish]

Risso, C., Németh, K., 2009. Field Guide to Phreatomagmatic Volcanism in association with a high density Scoria Cone Field: Malacara Tuff Cone and Carapacho Tuff Ring in the Llancanelo Volcanic Field near Malargüe City, Mendoza Province, Argentina. 3IMC. 3° International Maar Conference, April 14 - 17, 2009. Malargüe, Argentina, pp. 1-23.

Haller, M.J., Németh, K., 2009. Cenozoic Diatremes In Chubut, Northern Patagonia, Argentina. 3ICM. International Maar Conference, April 14 - 17, 2009. Malargüe, Argentina, pp. 1-23.

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