IODP Proposal Cover Sheet

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Galicia Margin Rifting

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Title	Continental breakup: the case for scientific drilling west of Galicia, Spain.
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Area	West Iberian margin

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Abstract

Over the last fifty years, our understanding of plate tectonics has grown hand-in-hand with discoveries made by scientific ocean drilling. As outlined in the IODP Science Plan, key remaining challenges include the nature of the “processes that initiate new plate boundaries, including continental rifting that forms new divergent plate boundaries, which can occur with little magmatic activity”. We propose to determine the temporal and spatial evolution of rifting to continental breakup, testing globally applied models, investigating the controlling mechanisms, and constraining the rates of the key processes. Whereas previous drilling on rifted margins has largely concentrated on basement highs, the analysis of new 3D seismic reflection data from across the Galicia margin, west of Spain now allows targeting of the complete synrift sequence at successive half-grabens. Systematic recovery of synrift sequences will provide a step-change in our understanding of the evolution of rifted margins, by providing the critical temporal controls on the rate and sequencing of extension processes.

Past 2D and 3D seismic surveys, numerical modelling, and observations of ancient margins now preserved within orogens have all improved our knowledge of the processes of rifting and breakup of the continental crust. Many of the key concepts in rifting and breakup were developed or tested with data from the Iberia margin: rift propagation, polyphase faulting, sequential faulting and rift migration. These hypotheses are all viable but imply key differences in terms of the timing of faulting, location of extension and rate of lithospheric separation during the rifting history. Continental rifting can thus only be understood if the fourth dimension, time, is well constrained. But seismic images reveal the geometry but not the absolute timing and rate of the key steps; onshore analogs of margins are discontinuous; and time-dependent input parameters of numerical models such as the velocity of plate divergence are often poorly constrained. The temporal and spatial evolution of rifting leading to continental breakup can only be determined by drilling and direct sampling of syn-rift sequences.

The magma-poor and sediment-starved setting of the Galicia margin, which is already partially characterised by previous ODP drilling and the recently acquired IODP-targeted 3D volume, provide a unique opportunity to determine the kinematic evolution of an archetypal rifted margin through new ocean drilling. Constraining the temporal evolution of this margin will provide crucial calibration data that could be extended to the tens of thousands of kilometres of rifted margins that flank the continents worldwide.

Scientific Objectives

To test the latest models of continental rifting to breakup. In particular to test the relative importance of depth-dependent thinning, polyphase faulting and migrating, sequential faulting, based on the specific predictions of the models, by:

1) systematically sampling across the margin, including characterization of the oldest synrift/prerift unit and the top of basement;
2) systematically sampling and dating sequences deposited during slip on the block-bounding faults in successive half-grabens above the S detachment - the bright reflection onto which the faults root. Such a record will provide timing constraints on individual faults across the distal margin and so reveal the temporal/spatial distribution and rate of extension of the complete margin;
3) systematically sample the synrift units deposited after local faulting but before crustal breakup to constrain the post-faulting uplift and rotation of the continental blocks;
4) sample the post-rift sequence to determine the subsidence of the margin and obtain discrete palaeoenvironmental data (e.g. the local CCD) through the Late Cretaceous and Cenozoic.

These drilling objectives will also provide data on the spatial and temporal variation in strain and strain rate during rifting to breakup, key parameters for numerical modelling of the thermal, rheological, and magmatic evolution of margins worldwide.

The 3D seismic survey collected specifically for this proposal will allow optimal site selection in order to meet these specific and achievable drilling objectives. This proposal will also build on legacy data from ODP Leg 103 to provide the first complete record of rifting to breakup for any margin worldwide.

Non-standard measurements technology needed to achieve the proposed scientific objectives

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Proposed Sites (Total proposed sites: 10; pri: 4; alt: 6; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
GAL-01A (Alternate)	42.1005 -12.4606	5115	1345	20	1365	GAL-01A: to sample the base of 4B, the whole of 4A, and the top of basement within block 4 to determine the timing of the onset of the latest faulting in the central part of the transect. Drilling strategy, APC/XCB to refusal, switch to RCB when necessary. Full objectives: 1365m penetration in 5115 m water. Alternate to primary Site GAL-08A. Second optimum location to reach the shallowest basement on block 4 with both the bottom part of 4B and unit 4C. To address drilling objectives 1, 2, 4.
GAL-02A (Primary)	42.1010 -12.4233	5025	985	0	985	GAL-02A: to sample the postrift, the post-faulting, synrift sequence 4C, and the top of the syn-faulting unit 4B to determine the timing of the end of faulting in the central part of the transect. Drilling strategy, APC/XCB to refusal, then switch to RCB. 985 m penetration in 5025 m water depth. Alternate site GAL-03A requires substantially deeper drilling (1084 m in total) in similar water depths. Optimum location to reach both units 4C and 4B. To address drilling objectives 2, 3, 4.
GAL-03A (Alternate)	42.1075 -12.4222	5016	1084	0	1084	GAL-03A: to sample the postrift, the post-faulting, synrift sequence 4C, and the top of the syn-faulting unit 4B to determine the timing of the end of faulting in the central part of the transect. Drilling strategy, APC/XCB to refusal, then switch to RCB. 1084 m penetration in 5016 m water depth. Alternate to primary Site GAL-02A. GAL-03A requires deeper drilling in similar water depths. Second optimum location to reach both units 4C and 4B. To address drilling objectives 2, 3, 4.
GAL-04A (Alternate)	42.1749 -12.5524	5005	545	71	616	GAL-04A: to sample the postrift, the base of syn-faulting sequence 5B, the whole of post-faulting 5A, and basement within block 5 to determine the timing of the onset of faulting in the western part of the transect. Drilling strategy, APC/XCB to refusal, switch to RCB when necessary. 616 m penetration in 5005 m water. Alternate site to GAL-09A. Second optimal location to sample shallowest basement and both Units 5B and 5A. To address objectives 1, 2, 4.
GAL-05A (Primary)	42.1058 -12.5482	5180	470	0	470	GAL-05A: to sample the postrift, the post-faulting, synrift sequence 5C, and the top of the syn-faulting unit 5B to determine the timing of the end of faulting in the western part of the transect. Drilling strategy, APC/XCB to refusal. Only switch to RCB if necessary. 470 m penetration in 5180 m water depth. Alternate Site GAL-06A requires substantially deeper drilling (830 m in total). Optimal location to reach the shallowest units 5C and 5B. To address objectives 2, 3, 4.
GAL-06A (Alternate)	42.1361 -12.5054	5020	830	0	830	GAL-06A: to sample the postrift, the post-faulting, synrift sequence 5C, and the top of the syn-faulting unit 5B to determine the timing of the end of faulting in the western part of the transect. Drilling strategy, APC/XCB to refusal. Only switch to RCB if necessary. 830 m penetration in 5020 m water depth. Alternate site to Site GAL-05A . Second optimal location to reach the shallowest units 5C and 5B. To address objectives 2, 3, 4.
GAL-07A (Alternate)	42.1848 -12.3256	4745	1020	55	1075	GAL-07A: to sample sequences 3C, 3B and 3A, and top basement within block 3 to determine the timing of the onset of the latest faulting in the central part of the transect. Drilling strategy, APC/XCB to refusal, switch to RCB when necessary. Partial objectives: 1075 m penetration in 4745 m water. To address objectives 1, 2, 3, 4.
GAL-08A (Primary)	42.0964 -12.4628	5110	1210	87	1297	GAL-08A: to sample the base of 4B, the whole of 4A, and the top of basement within block 4 to determine the timing of the onset of the latest faulting in the central part of the transect. Drilling strategy, APC/XCB to refusal, switch to RCB when necessary. Full objectives: 1297m penetration in 5110 m water. Alternate site GAL-01A (1365m penetration in 5115 m water, same targets but deeper setting). Optimum location to reach both the bottom part of 4B and the shallowest basement on block 4. To address drilling objectives 1, 2, 4.
GAL-09A (Primary)	42.1675 -12.5522	4963	493	39	532	GAL-09A: to sample the postrift, the base of syn-faulting sequence 5B, the whole of post-faulting 5A, and basement within block 5 to determine the timing of the onset of faulting in the western part of the transect. Drilling strategy, APC/XCB to refusal, switch to RCB when necessary. 532 m penetration in 4963 m water. Alternate sites GAL-04A and GAL-10A are both require slightly deeper drilling (616 and 625 m respectively) in similar water depths. Optimal location to sample shallowest basement and both Units 5B and 5A. To address objectives 1, 2, 4.

Proposed Sites (Continued; total proposed sites: 10; pri: 4; alt: 6; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
GAL-10A (Alternate)	42.1591 -12.5538	4910	600	25	625	GAL-10A: to sample the postrift, the base of syn-faulting sequence 5B, the whole of post-faulting 5A, and basement within block 5 to determine the timing of the onset of faulting in the western part of the transect. Drilling strategy, APC/XCB to refusal, switch to RCB when necessary. 625 m penetration in 4910 m water. Alternate site to Site GAL-09A. Second optimal location to sample shallowest basement and both Units 5B and 5A. To address objectives 1, 2, 4.