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START DATE: 01/01/2002
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AWARD REF NUMBER: NER/T/S/2000/01018

Name and Address of any other collaborating organisation(s) involved in research:

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b) Statoil (UK) Ltd,
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2.TITLE OF RESEARCH PROJECT:
Quantifying fault zone evolution and basement reactivation in passive margins.

3.OBJECTIVES OF THE RESEARCH:

i) Develop and implement state of the art methodologies for acquiring fault data in digital format onshore from previously constrained reactivated and non-reactivated basin-involved fault zones. Deliverable – onshore digital fault datasets

ii) Develop and implement methodologies for acquiring compatible fault data in digital format from offshore seismic data. Deliverable – offshore digital fault datasets

iii) Integrate onshore and offshore fault data in ArcViewÔ and produce 3D visualization using GoCadÔ. Deliverable – 3D visualizations of onshore and offshore datasets.

iv) Test criteria by which the spatial attributes of onshore fault data may be scaled to offshore and develop generic software tools that spatially characterise fault zones in 2 & 3D and detect reactivation. Deliverable – A definition of new methodologies and provision of prototype software tools to the consortium members.

v) Perform characterisation and a reactivation assessment on a selected basin margin structure from further off-shore (possibly Rockall Trough). Deliverable - A structural characterisation and assessment of the importance of reactivation in a deeper water basin margins.

4.ACHIEVEMENTS OF THE RESEARCH

The scientific aim of this project was to understand how basement fault reactivation influences basin evolution in passive margins by investigating faults in basement onshore and comparing these structures with equivalent basin-involved faults in sedimentary cover offshore. Objectives 1-3 are primarily concerned with developing the research methodologies and analytical tools, whilst objectives 4 and 5 relate to their scientific application in rifted crust. Objective 1. This objective has been achieved by developing a novel workflow ('GAVA' - Geospatial Acquisition Visualisation and Analysis) to capture digital field-based geological data. The method uses GPS surveying and laser scanning techniques, and has been applied to 6 field areas with well-exposed reactivated and non-reactivated basement faults in England, Scotland, Norway and western Greenland. This work has been pivotal in establishing the Durham group as national leaders – with a growing international profile – in the acquisition, visualisation and analysis of quantitative field-based geological data. It has also led to the successful formation of Geospatial Research Ltd, a spin out company set up to commercialise GAVA with funding from the NERC, the University and the Regional Development Agency, OneNE (see section 6). Objective 2. This objective has been achieved by interpreting high-quality 2 and 3D seismic datasets from 7 reactivated and non-reactivated fault systems worldwide (see 5ii). The offshore interpretations and fault models are in a format that is fully compatible with the onshore fault data. Added-value arising from this research included training in 3D seismic interpretation methods for a NERC funded MSc Geophysics student. Additional in-kind support from Statoil UK, Schlumberger and Badley Geosciences enabled us to set up industry-standard seismic interpretation and 3D visualisation facilities that were critical in reaching this objective. Objective 3. This objective has been achieved by integrating 3 onshore - offshore fault datasets (North Scotland-West Orkney Basin; Lofoten Islands-Ribban Basin (Norway) & West Greenland-Davis Strait) in ArcView and/or GoCad. Additionally, we have produced an immersive 3D visualisation of the N. Scotland-WOB dataset using Schlumberger's Inside Reality software. Objective 4. This objective was revised due to a lack of suitable 3D seismic datasets and following our discovery that some key fault attributes cannot be reliably scaled (see 5ia). Our new strategy exploits the different inherent strengths of onshore and offshore fault data. We have constrained the geometry and slip kinematics of reactivated & non-reactivated faults onshore, and used well-calibrated 3D seismic data to investigate the geometry and growth of equivalent fault systems offshore. Our studies reveal that pre-existing basement structures are, in a great majority of cases, oblique to far-field tectonic stresses leading to signature patterns of oblique, complex fault motion and growth. We have generated a new suite of generic 3D kinematic structural models which can be applied to hydrocarbon E&P in basement-influenced basins. We have successfully tested these models in offshore settings using high resolution 3D seismic data from the Norwegian, NW Australian and Vietnamese shelves. Following consultation with our partners, we decided to develop a generic solution

to allow recognition of basement reactivation in ocean margins and continental rifts, which is not tied to any specific proprietary software package. To this end, we have created a Fault Reactivation Decision Support System ('FREDSS'), a database of fault geometries, growth characteristics and other quantitative attributes. This will enable geoscientists to risk the likelihood of fault reactivation at an early stage in the E&P cycle using 1D tectonic subsidence curves and knowledge of the regional tectonic history and gross basement structure. FREDDS can also be used later in the E&P cycle to compare trap and reservoir geometries with the geospatially-referenced models of reactivated fault systems acquired during the present study. Objective 5. This objective has been achieved through structural analysis of a 3D seismic dataset from the Nyk High, a deep water horst in the NW Vøring Basin. Preliminary analysis of 2D data showed that the Rockall Trough was unsuitable owing to the relatively poor age constraints and equivocal evidence for fault reactivation. The Nyk High study has given rise to a testable model for the controls on fault reactivation during continental break-up along volcanic passive margins.

5. References:

Details of all publications, reports and presentations.are on a separate document. Discovery metadata relating to onshore and offshore fault interpretations generated during the course of the project will be lodged with the BGS National Geoscience Data Centre. Details can be found in our Data Management Plan, available at the URL below.

iii) Please note that all the minutes and presentations from Steering Group meetings can be found at: http://www.dur.ac.uk/react.res/RRG_web/link_project.htm Selected publications are also available from:
http://www.dur.ac.uk/react.res/RRG_web/recent_publications.htm