EARTH SYSTEMS IN THE SCOTIA ARC REGION

Course Curriculum for Student Credit

UNIVERSITY OF TEXAS AT AUSTIN / GEOLOGICAL SOCIETY OF AMERICA 2012-2013 CRUISE

General Background

Antarctica and the Scotia Sea – Tectonics, Climate & Life. For the 125th anniversary of the Geological Society of America, we are sponsoring a 25 day fieldtrip to explore the geology, tectonics, climate and glaciology of the Falkland, South Georgia and Orkney Islands and Antarctic Peninsula. This trip will be led by Ian Dalziel (University of Texas at Austin), and he and Richard Alley (Penn State University), Rob Dunbar (Stanford University), Rudolph Trouw (Federal University of Rio de Janeiro, Brazil) will give a series of lectures for all participants. Trip timeline: 12/27/2012 – 1/20/2113; see http://www.cheesemans.com/antarctica_jsg.html for more information.

In conjunction with the trip we will offer a credit generating course for student participants. Students may sign up for the course through the University of Texas at Austin Jackson School of Geosciences for the Spring 2013 term or through their own university as some type of independent study course. In the latter case, the instructors on the cruise will transmit the student's grade to that department.

Scientific Scope

THE EARTH SYSTEM ON DISPLAY DURING THE VOYAGE: The Scotia Arc is the complex of submarine ridges and rugged islands joining the Andean Cordillera to the Antarctic Peninsula and including the active South Sandwich Islands volcanic arc at its eastern extremity. A zone of left-lateral transform motion between the South American and Antarctic continents, it encloses the Scotia Sea and Drake Passage, the deep "gateway" through which flows the globe-encircling Antarctic Circumpolar Current, the most powerful in the world's oceans. We will cross the Antarctic Polar Frontal Zone during the voyage and see it's impacts on marine life as well as modern glacial regimes, including the temperate subpolar glacial systems of South Georgia to the cold glacial environments of the Weddell Sea.

Our expedition will visit:

- Falkland (Malvinas) Islands, with the classic sedimentary cover of the Gondwana supercontinent and a huge diversity of species
- South Georgia, an incredibly rugged island microcontinent comprising a marginal basin turbidite infill displaced eastward from the southernmost Andean Cordillera, with thriving colonies of penguins, seals, and albatross
- South Orkneys with uplifted Gondwanide margin fore-arc rocks and nesting Snow Petrels
- Antarctic Peninsula and South Shetland Islands, the "Antarctandes," including the active Deception Island volcano in the Bransfield back-arc rift and uplifted subduction complexes

Specific topics:

Topics to be covered for the course are outlined below. Note: topics designated with [1] will be experienced through actual field observations; those designated [2] will be experienced through overall presence in the region and study of computer images of the ocean floor beneath the ship combined with other geophysical data and supplemented and explained by the shipboard lecturers and by literature made available through on board computers.

Tectonic evolution of the Scotia arc

- Experience throughout the cruise will bear on this overall topic; landings and geologic observations in Tierra del Fuego, South Georgia Island, the South Orkney and South Shetland island groups and the Antarctic Peninsula will all contribute to this learning experience – combined with study of multibeam images of the ocean floor beneath the ship and gravity and magnetic maps available through the onboard computers. [1,2]

Cordilleran tectonics

- Andean Cordillera in Tierra del Fuego and on the Island of South Georgia [1]; processes of orogenic uplift
- Pacific margin magmatism in Tierra del Fuego, the South Georgia microcontinent and the Antarctic Peninsula [1, 2]

Subduction processes

- Subduction complexes of the South Orkney Islands and South Shetland Islands (Elephant Island) [1] and their relation to regional tectonic development [2].

Back arc basin formation

- Origin, development and orogenic inversion of the Mesozoic Rocas Verdes in the southernmost Andean Cordillera and South Georgia Island [1,2].

- Tectonically active Bransfield Basin back-arc rift and the active Deception Island volcanic caldera [1.2].

Cryosphere

- Ice sheets of the Antarctic Peninsula, South Georgia, the South Orkney and South Shetland Islands including observations of change over the past century [1.2]
- History of Antarctic glaciation [2]
- Ice mass change in Antarctica [2]

Climate

- Climate of the high southern latitudes [2]
- Climate change in high southern latitudes from a global perspective [2]

Oceanography

- Ocean circulation and impacts on ecology
- Decadal Changes in the Antarctic Peninsula region
- Bottom water production and gas transfer in the Southern Ocean

Paleobiogeography

- The pre-Neogene South America-Antarctic Peninsula isthmus as a land bridge for terrestrial biota [1,2]
- The opening of Drake Passage as a barrier to migration of terrestrial biota and a gateway to dispersal of marine organisms [2]

Tectonics and climate

- Climatic effects of the Andean Cordillera [1,2]
- Opening of the Drake Passage deep oceanic gateway, the origin and development of the Antarctic Circumpolar Current and the onset of Antarctic glaciations [2]

Supercontinentals and supercontinental fragmentation

- Geology of the Falkland Islands – the Gondwana craton cover sequence and its role in the initial understanding of continental drift. [1]
- Rotation and translation of the Falkland Islands (Lafonian) microplate during initial fragmentation of Gondwanaland [1]; processes of supercontinental fragmentation [2].

History of scientific exploration in the Southern Ocean and adjacent continents and islands

- The classic explorations and scientific endeavors of Cook, Darwin, Gerlache, Nordenskjold, Bruce (the Scottish National Antarctic Expedition), Wilkes (the United

States Exploring Expedition), Wordie (geologist on board Shackleton's *Endurance* expedition), Murray (the Discovery expeditions) and others will be interwoven through the lectures. [2]

Course requirements:

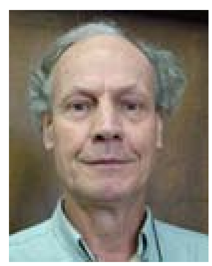
1. Students will be expected to attend all on board lectures and participate in all shore excursions planned for career earth scientists.

2. They will maintain a field note book detailing their observations. This should include a cruise track and localities map, maps and sketches of geological field relations; it may also contain annotated photographic images.

3. They will write a report on some aspect of the cruise that particularly interested them, preferably involving interaction between tectonics and the regional and global environment.

4. They will make a presentation during the spring of 2013 at their home institution about Earth systems in the Scotia arc region.

The number of credits for the course may vary with the university. A grade will be assigned based on a combination of the field note book, the report and the quality of the presentation at the student's home institution. The field note book and report will be judged by the on board science lecturers, the presentation by a faculty member at the home institution. Professor Ian Dalziel of the Jackson School of Geosciences, The University of Texas at Austin will be responsible for assigning the final grade.

Trip leaders & lecturers (left to right): Ian Dalziel (University of Texas at Austin), Richard Alley (Penn State), Rob Dunbar (Stanford) and Rudolph Trouw (Federal University of Rio de Janeiro).