Coral reef sediment dissolution in a changing ocean: insights from a temporal field study

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Southern Cross University, Coffs Harbour, NSW

Calcium carbonate sediments form an essential part of coral reefs yet have often been overlooked when studying the effects of future ocean acidification (OA). This original field-based research aims to assess the temporal variability of organic and inorganic sediment metabolism under ambient and elevated pCO_2. OA caused a shift from net precipitation to net dissolution, but the sensitivity to OA varied seasonally, depending on interactions with temperature and benthic productivity. A slack-water approach of net ecosystem calcification revealed that sediments can play an important role in carbonate budgets, particularly at night, and become increasingly important as the oceans continue acidifying.

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Diamonds — time capsules of volatiles and the key to dynamic Earth evolution

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The Earth consists of a core, mantle, crust, and atmosphere. Noble gas analyses of basaltic rocks indicate that the present-day structure of the Earth comprises a slightly degassed lower mantle and highly degassed upper mantle. The extent and timing of mantle in- and out-gassing and sources of volatiles are, however, not well-constrained and require quantification for development of a high-resolution model of the structure of the Earth's mantle and its evolution to a differentiated state. Noble gas data for the Earth's mantle are still almost exclusively limited to two temporal end-members: i) the present-day mantle, with compositions from modern basalt glasses, and ii) the undifferentiated primordial Earth at 4.6 Ga, with data from extra-terrestrial samples

and nuclear synthesis models. Further, the noble gas compositions of important reservoirs — the deep mantle, (subducted) oceanic crust and sub-continental lithospheric mantle (SCLM) — are not well established.

The objective of this thesis is to address the noble gas composition (with a focus on helium) of these reservoirs through a study of diamonds from the Southern Hemisphere (Brazil, DRC Congo, Southern Africa, Australia). Diamonds form at depths of ~120–800 km and cover most of the history of Earth with ages of 3.5 to 0.05 Ga. Diamonds, being chemically inert, can preserve information on the fluid and mantle composition at the time of diamond formation. Specific objectives are to explore the potential of U-Th/He systematics for dating fibrous diamonds, the influence of volatile subduction on the heterogeneity in the SCLM, and how helium isotopic compositions have evolved over time in the SCLM.

Fibrous diamonds are generally assumed to have formed shortly before the kimberlite (volcanic) eruption but there is currently no way to date these diamonds. The U-Th-Sm/He systematics of fibrous Congo and Jwaneng diamonds showed that in most cases U-Th/He ratios are sufficiently high to produce significant radiogenic ^{4}He to provide age constraints, and some fibrous diamonds are up to several 100 Myr older than the kimberlite eruption age.

High-density fluid (HDF) inclusions with different major element compositions found in South African fibrous diamonds have different noble gas compositions that show these fluids originated from subducted sediments and oceanic crust and had either limited interaction with the SCLM (silicic-low Mg carbonatitic fluids) or significant interaction with the SCLM (saline fluids). A positive correlation between $^{3}He/^{4}He$ and $\delta^{13}C$ values in lithospheric (150–190 km depth) diamonds from Argyle (Australia), together with low $^{40}Ar/^{36}Ar$ and He/Ne isotopic compositions, demonstrates a subduction influence caused by high U-Th/^{3}He ratios and thus low $^{3}He/^{4}He$ ratios in subducted organic material. A noble gas depth profile of these diamonds shows fluid-rock interaction over scales of at least 15 kilometres above the accreted subducted material. Superdeep Brazilian diamonds from the transition zone (410–660 km depth), in contrast, show a negative correlation between $^{3}He/^{4}He$ and $\delta^{13}C$ values. $^{3}He/^{4}He$ ratios are decoupled from trace elements and Pb-Sr isotope systematics that have characteristics of subducted material. This indicates that the deeply subducted sediments have been deprived of U-Th-He and a high $^{3}He/^{4}He$ source, located in the deep mantle (>410 km depth), is dominating the helium budget.

Previously dated monocrystalline diamonds (with multiple ages ranging from 0.07 to ~3.4 Ga) were analysed for trace elements and He-Ar isotopic compositions and, after correcting for radiogenic ingrowth since diamond formation, a large variation remains in $^{3}He/^{4}He$ values at ~1.0 Ga that can be explained by mixing between mantle and subducted components. Given the preservation of heterogeneities, it is difficult to develop a simple noble gas evolution curve for the SCLM. From examination of fibrous and monocrystalline diamonds from different formation depths, formation ages, and geographic locations this study showed the large influence of subduction at the base of the lithosphere and a more SCLM-like noble gas composition at shallower depths. The addition of U-Th by subducted sediments

could result in lower $^{3}He/^{4}He$ ratios in the SCLM compared to the upper mantle.

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Managerial quality, firm performance, technical efficiency and productivity in New Zealand

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The objective of this thesis is to investigate the effect of managerial quality and business environment on the ownership–performance, technical efficiency and productivity nexus of firms in New Zealand (NZ). Despite the growing number of theoretical and empirical studies examining the determinants of firm performance and productivity, managerial quality has traditionally been ignored. Since the global financial crisis, there has been renewed interest in investigating the factors influencing firm performance and productivity growth to enable managers to position their firms to be competitive in the growing and unpredictable global marketplace. Leibenstein's x-efficiency theory provides a sound theoretical basis for incorporating the role of managerial quality into modelling technical efficiency, productivity and firm performance. This thesis is the first attempt to extend the traditional model of efficiency, productivity and firm performance by incorporating managerial quality using Leibenstein's x-efficiency framework to explain NZ's underperformance, despite its policies and institutional quality being close to or at best practice under Organisation for Economic Co-operation and Development (OECD) guidelines. To achieve the objectives and provide sound policy recommendations, three empirical studies were conducted to present new empirical evidence in the NZ context.

The first study used a meta-analytical framework to examine the effects of managerial quality on the ownership structure–firm performance nexus in OECD countries. A meta-analysis of data from 46 studies on OECD countries found that heterogeneity in the effects of ownership structure on firm performance may be explained by variations