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Comparative Diagenetic characteristics of Quaternary coastal carbonates: analysis of key global localities

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The focus of this research is to study the diagenetic changes of Quaternary carbonates from some of the worlds most notable coastal limestone deposits; Bermuda, The Bahamas, Hawaii and The Coorong region of South Australia. Sample suites have been collected from each of the field regions, with each succession spanning as much of the Quaternary as possible in each location. The ages of the deposits have been determined primarily by stratigraphic position with additional dates and age confirmation provided by amino acid racmization. The research examines the progressive diagenetic alteration through the samples suites, focusing on the neomorphic changes that occur, the production of intra- and inter-granular cements, and the occlusion of porosity and permeability in the limestones. The study will result in an accurate diagenetic history of each of the four field areas and allow global comparisons to be made between the deposits, highlighting the similarities and differences cause by age, climate, original composition, sea level and water chemistry on the diagenetic processes in limestone deposits.

The money provided by the IAS postgraduate grant scheme was used to undertake geochemical analysis at the Advance Analytical Center at James Cook University, Townsville Australia. This geochemical analysis was X-ray diffraction analysis (XRD) and general area diffraction detector system analysis (GADDS) of each of the sample suites from the various coastal regions. Quantitative XRD provided the opportunity to determine the bulk composition of each sample, allowing any changes in this bulk composition of the sample suites to be traced through time, providing an overview of the rate of diagenetic alteration that is occurring between the three calcium carbonate polymorphs (aragonite, high Mg-calcite, and calcite). Quantitative XRD was also used to identify any minor mineralogical components of the rocks of non-carbonate origin that may have an affect on the overall diagenesis of the samples.

XRD analysis shows that the samples from The Bahamas, Bermuda and Hawaii are almost 100% calcium carbonate in composition, with only minor non-carbonate minerals identified generally amounting to less than 2% of the total bulk composition. The results from Kaui'i, Hawai'i show an almost perfect trend in alteration, with the amount of the unstable calcium carbonate polymorphs, aragonite and high Mg-calcite, decreasing and a corresponding increase in the amount of calcite in the sample through time. The results of XRD show that there is an initial period where little change occurs in the composition of the sample through time, there is then a rapid increase in the alteration that has taken place occurring in the sample dated at Marine Isotope Stage 9 and that this alteration reaches completion by the samples dated at MIS 11 in age. This suggests that it takes a

while for the polymorphic alteration of calcium carbonate to occur in Hawaii but once it has begun reaches completion very rapidly.

The XRD results of samples from The Bahamas and Bermuda are not so straight forward, with the general trend indicating an overall increase in the stable calcite over time and a decrease in the unstable polymorphs. However, the individual sample results do fluctuate within this trend, suggesting the local environment from which the sample were collected has a large influence on the polymorphic alteration.

Results from the Coorong, South Australia show a varying amount of quartz on the samples ranging from 0% to 60%, with an average of 30%. With respect to the carbonate portion of the samples, again the overall trend of an increase in the amount of calcite over time is seen. The influence of the varying percentages of quartz within the samples is seen, with samples with higher amounts of quartz in the composition generally displaying a slower rate of polymorphic alteration and retain higher relative percentages of the unstable polymorphs.

The use of GAADS turned out to be limited in its scope with the laser beam being too large to successfully analyze single grains in the sample with smaller carbonate grains. The process only returned useful results for those samples with larger carbonate grains and worked best with oolite samples of The Bahamas. In these samples the process was extremely useful as it was able to locate a single crystal of calcite in an ooid composed primarily of aragonite pinpointing the exact point the polymorphic transformations began.

This basic geochemical analysis provided information about the composition of each of the sample in the various suites and highlighted issues for further investigation