Carbonate petrography of Jurassic seamounts and associated facies, Northern Apennines, Italy

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INTRODUCTION

The field area of this part of the Keck Italy Project encircles the village of Castelletta in the Marche Region of the Northern Apennine mountains and has a location of 43°24'00"N and 13°00'00"E. In this area a carbonate platform began to form during the Hettangian in the Early Jurassic, producing the Calcare Massiccio limestone. Subsequent normal faulting due to the opening of the Liguride Ocean broke up this platform into a series of higher seamount areas and lower basins in a horst and graben process. The platform was then drowned, but sedimentation continued, resulting in two different sedimentary sequences being deposited. These are the Bugarone Formation on the seamount tops and the Corniola Formation in the basins (Bice and Stewart, 1990). In addition, a slope environment was created as debris from faults and seamount tops was transported down the side of the seamounts and was deposited in the basins. Overlying these are the Diaspri and Maiolica formations, which were deposited during the Late Jurassic and Early Cretaceous.

METHODS

Field Methods. Maya Del Margo and I mapped an area of approximately 5.75 km^2 which contained two seamount sequences and two basinal sequences (figure 1). At each location I collected representative samples of each formation that was present in as near the stratigraphic order as possible.

Laboratory Methods. Thin sections were prepared of the samples, and select slides were then stained using alizarin red sulphonate and potassium ferricyanide. I examined oiled thin sections using a hand lens, petroscope, and petrographic microscope, taking note of fossil distributions and rock porosity and disturbance.

RESULTS

Both seamounts progress from peloid dominated rocks of Calcare Massiccio type to biomicrites of Bugarone type with abundant fossils to sparites and finally Maiolica-type dense micrites which contained few or no macrofossils. Most of the pore space and extensive sediment disturbance in both sections occurs near the top. There are some fractures, and hematite has collected along those of Seamount 1. The first seamount also has large amounts of dolomitization which continue into the first slope facies, progressing up-strata from scattered euhedral rhombs to complete replacement of the micrite with sparry dolomite, then tapering off to sparse crystals again, resulting in a thin zone of dolomitization. Dolomite is completely absent from the second seamount.

In thin section, samples from the two slopes appear to be very different. The first contains many microbreccias, extensive spar replacement, chert, and high porosity while the second has no microbreccias, no spar or chert, and low porosity. However, when observed in the field, both slopes have breccias with boulder-size clasts. Therefore Slope 1 contains sediments that are brecciated on a microscopic scale as well as large clast breccias that can be easily identified in the field. Slope 2 contains only the large clast breccias, which are cemented together by mudstones. Fractures and stylolites are common in samples from both locations. Slope 1 has been dolomitized in a similar fashion to Seamount 1 but does not form a single zone, and dolomite occurs additionally as spar cement in the microbreccias. Slope 2 has no dolomite.

The basinal sequences are characterized by the less fossiliferous mudstones and wackestones of the Corniola Formation. These rocks consist of micrites and sparites, with some breccias occurring mid-section at both locations. Peloids are absent in the first basin and abundant in the second. Chert is found as nodules and thin interbedded layers in hand sample, and also replaces micrite in some areas There is sparse ferroan calcite, and syntaxial overgrowths of some skeletal fragments. Fossils and sediments exhibit some degree of deformation and replacement and also show stratification and grading in some samples. Lamination, possibly of microbial origin, is also found. Fractures and stylolites occur, but not as commonly as in the slope sequences, and sediment disturbance is relatively low.

DISCUSSION

Seamount. The rocks of Seamounts 1 and 2 sections display a progression from the shallow platform (peloid limestones) to a shallow or subtidal marine (biomicrites and dolomite) to a deeper marine environment (dense micrites). I believe that the hematite found along fractures, stylolites and pore spaces in all sections is the result of pyrite collecting along these surfaces and being altered to hematite during the uplift of the rocks during the later orogenic episodes that folded the Apennine mountains.

The seamount paleoenvironment appears to have been a shallow marine sea dominated by nektic to nekto-benthic ammonites (Flügel, 1978) feeding on organic detritus from such sources as planktonic foraminifera and calcispheres. A large benthic community of epifaunal and infaunal organisms existed on the sea floor, as evidenced by bioturbation preserved in the sediment.

Slope. Diagenesis along the slopes began when sediment scraped off by faulting and swept off seamounts was carried downslope (Colacicchi and Baldanza, 1986). The material was cemented by spar or micrite and eventually formed a somewhat solid substrate, but repeated flows resulted in continuous disturbance. Repeated burial of old sediments by new flows could have caused the stylolites and fractures present in these rocks.

The slopes contain many of the same fossils as the seamount facies, but their location in clasts and large chunks of rock spread throughout the slope indicate that these fossiliferous rocks were transported down the slopes from the above seamounts. The introduction of algae and fusilinid foraminifera, and the decline of planktonic foraminifera and gastropods gives evidence of a shift to a deeper water setting. This, when combined with the high energy-produced deposition and continual brecciation, establishes a good outline of a slope facies environment, in which any permanent organisms would have to be able to withstand large amounts of turbulence and shifting of the substrate.

Basin. The breakage and replacement of skeletal materials and the presence of breccias, combined with a stratification and grading of these sediments that is not found along the slopes, points to a basinal origin, in which seamount and slope material was transpoted via debris flows and periodic turbidity currents into the basins. Chert is present in the rocks as silica replacement of calcite particles and cements. The presence of ferroan calcite suggests an anoxic environment or burial of the rocks, which would also account for the stylolites and fractures. Syntaxial overgrowths and calcite spar replacement show that the basin was not below the CCD. The absence of aragonite indicates secondary cementation by calcite, as there is no dolomite present. There are no freshwater features, and the only apparent environmental progression is from shallow to deeper marine.

Organisms living in the basin were ammonites, crinoids, brachiopods, some bivalves, sponges, algae, and benthic foraminifera. The lack of sediment disturbance indicates low bioturbation, which suggests that the infaunal tier was not well-developed, or the sediment deposition rate may have been too high to support a lot of substrate-dwelling organisms.

DOLOMITE

I am uncertain as to the diagentic history of the dolomite in the two sections, and why dolomitization would be so prevalent in one seamount and absent in the other. It is evident, though, that the two seamounts had different histories, one of which resulted in dolomitization while the other produced only calcite. A possible explanation of the dolomite is evaporation in a shallow water marine or lagoon environment, producing a dolomite "crust" on top. However, the presence of beginning dolomitization in the Maiolica limestones overlying the seamount Bugarone and the lack of strong evidence to support a Jurassic evaporite environment in this area adds much doubt as to whether this is likely, although an abundance of calcispheres, particularly in the seamount rocks, could be possible support of a lagoonal tidal flat environment (Bagby, 1989). Other explanations include burial compaction forcing dolomite-rich waters to the surface and encouraging dolomite precipitation, or a change in sea water salinity or temperature that would increase the tendency of dolomite to precipitate (Morrow, 1990). More research needs to be done on dolomitization in order to provide answers to explain the difference in these two seamounts.

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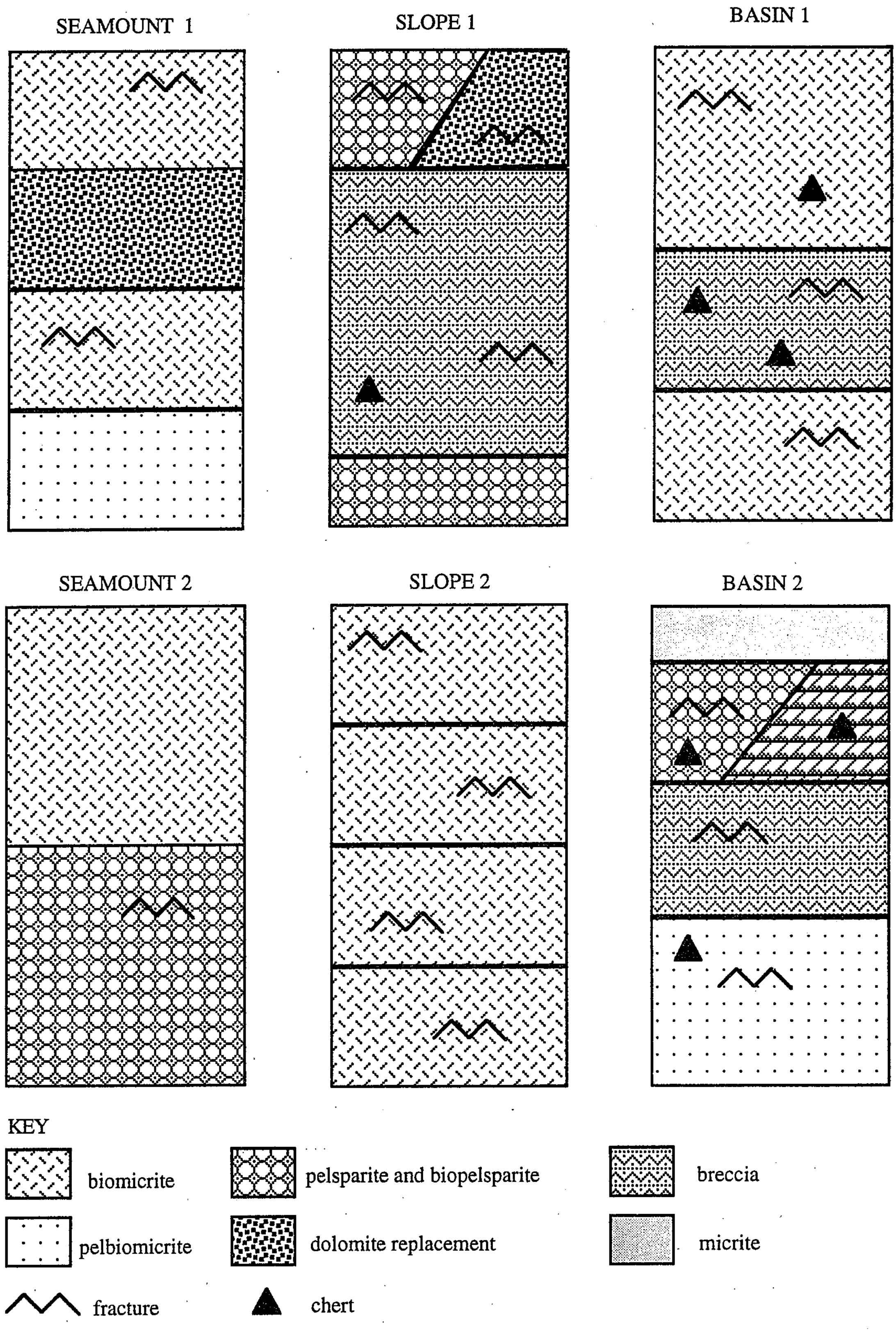

Figure 1. Stratigraphic section of each seamount, slope, and basin location.