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Front Cover: Close-up view of a patch-reef coral head in Grahams Harbor, north of Dump Reef. As shown here, Caribbean shallow-water reefs have declined since the mid-1980s and are now largely overgrown by fleshy green macroalgae and a variety of encrusting organisms. See Curran et al., "Shallow-water reefs in transition," this volume, p. 13. Photograph by Ron Lewis.

Back Cover: Dr. A. Conrad Neumann, University of North Carolina, Chapel Hill, NC, Keynote Speaker for the 11th Symposium and author of "Cement loading: A carbonate retrospective," this volume, p. xii. Photograph by Mark Boardman.

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CONFIRMATION OF THE GAULIN CAY MAGNETOTYPE DIRECTION, SAN SALVADOR ISLAND, BAHAMAS

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ABSTRACT

The Gaulin Cay paleomagnetic sample locality was resampled in order to verify the positive paleomagnetic conglomerate test, which was based on a small sample size. The new data set adds 10 directional data points, providing for a comparison of two paleosols based on sample sizes of 8 and 10. The revised directions are identical and are only 2° away from the composite mean determined in the initial study. This confirms the original Gaulin Cay conglomerate test and strongly supports the validity of paleomagnetic correlation of paleosols as a stratigraphic tool on San Salvador Island.

INTRODUCTION

Over the years, paleomagnetic studies have produced three magnetotype directions, which appear to be useful in correlating paleosols, on San Salvador Island (Panuska et al., 1995a; Panuska et al., 1999). Correlation of these paleosols in turn appears to allow recognition of various stratigraphic units (Panuska et al., 1997; Panuska et al., 2001). However, the validity of using of paleomagnetic data for stratigraphic investigations relies on the stability of the paleomagnetic signal.

Initial evidence for paleomagnetic stability on San Salvador was somewhat circumstantial until the discovery of the Gaulin Cay locality (Panuska and Mylroie, 1993; Kirkova, 1994; Panuska et al., 1995b). At the Gaulin Cay paleomagnetic sampling locality, two paleosols are in direct contact, with the upper paleosol containing clasts of the lower paleosol. A positive paleomagnetic conglomerate test was obtained as both paleosols yielded statistically similar directions (were penecontemporaneous?), while the clasts produced random directions. These findings argue strongly for a stable paleomagnetic direction, essentially dating to the origin of the rock.

While the original Gaulin Cay conglomerate test is statistically significant at 95% confidence, the study was based on only 4 samples from each paleosol (Kirkova, 1994; Panuska et al., 1995b). In an effort to verify these results with a more satisfactory number of samples, the Gaulin Cay locality was resampled in January 2001. The number of usable data points was extended to 18 and confirm the conclusions of the initial study.

GEOLOGIC SETTING

Carew and Mylroie (1995) identify two Pleistocene formations and one Holocene formation on San Salvador Island. The oldest unit, the Owls Hole Formation, is a bioclastic/peloidal calcarenite of eolian origin. Overlying the Owls Hole is a terra rossa paleosol followed by the Pleistocene Grotto Beach Formation.

Grotto Beach rocks consist of a basal transgressive eolianite facies overlain by a variety of shallow marine facies including coral reef deposits. The marine deposits grade upward into regressive-phase subaerial dune deposits. The Grotto Beach Formation is the only unit on San Salvador that contains significant numbers of ooids, and it is also overlain by a terra rossa paleosol.

The uppermost unit is the Holocene Rice Bay Formation. This unit consists of poorly cemented peloidal/bioclastic sands of beach and eolian origin. The stratigraphic succession from eolian to beach members is thought to reflect late Holocene sea level rise (Carew and Mylroie, 1995).

Prominent paleosols are found at the contacts between the formations and represent extended periods of sea-level lowstands, characterized by accumulation of wind-blown dust (Carew and Mylroie, 1995). Because the paleosols are not distinguishable on the basis of mineralogy (Boardman et al., 1995) and because the stratigraphic relationships of the bounding rocks may be equivocal, paleomagnetic directions were investigated as a possible correlation criterion (Mylroie et al., 1985; Stowers et al., 1989; Panuska et al., 1991, 1995a, 1997; Obid and Panuska, 2001). Confidence in San Salvador's paleomagnetic data is due in large part to the Gaulin Cay conglomerate test (Kirkova, 1994; Panuska et al., 1995b). Given the findings of Obid (2000) and Obid and Panuska (2001), which advise caution when using mean directions based on small sample size, it is important to bring the Gaulin Cay test up to the more stringent requirement of a minimum of 8 data points per unit.

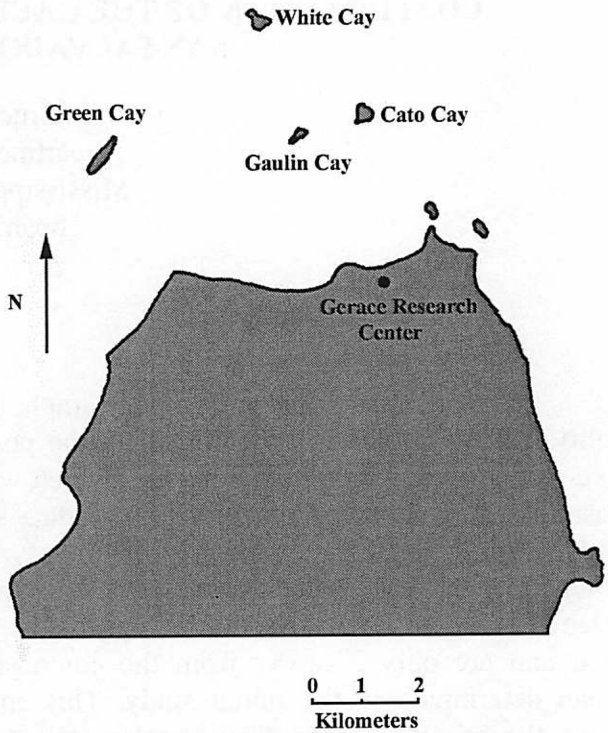

Figure 1. Location map of Gaulin Cay.

STUDY AREA AND METHODS

Gaulin Cay is a small, flat island, located in Grahams Harbour, approximately 2.5 km north of the Gerace Research Center (Figure 1). The conglomerate test site is located on the northeast portion of the island, on a storm-wave washed coastal exposure. The original conglomerate test (Kirkova, 1994; Panuska et al., 1995b) was performed on a paleosol breccia deposit where clasts of the lower, laminated paleosol occur in a massive paleosol, directly overlying the laminated paleosol. In the initial study, between one and three cores were drilled from each clast. Paleomagnetic directions showed excellent agreement within clasts but showed statistically random directions from clast to clast. This demonstrated that the magnetization has been stable since the time of clast deposition; transport forces overwhelm any tendency for clast alignment with the geomagnetic field. The randomness of the clasts was well-established in the initial study and was not considered further.

Logistic constraints precluded a more thorough sampling of the conglomerate test locality during the first study. Therefore, a more complete sampling program was conducted in January, 2001. During this field investigation, 39 samples were collected from 2 clusters from the lower, laminated paleosol and 2 clusters from the upper, massive paleosol.

Upon examination of cores in the laboratory, several samples were found to contain small paleosol clasts; they were deemed unreliable and were not measured. Of the remaining samples, only 22 had sufficient intensity and stability of measurement to be analyzed. These samples were measured on a Schonstedt SSM-1A spinner magnetometer. To remove secondary components of magnetization, samples were cleaned in 25 Oe (Oersted) increments, using a Molespin Shielded Alternating Field Demagnetizer. When rotational remanent magnetization (RRM) or anhysteretic remanent magnetization (ARM) was suspected, repeat measurements were made after a second cleaning in opposite sample orientation with respect to the cleaning field. In this way, the obscuring effects of RRM or ARM could be removed by averaging the measurements from the two cleaning orientations.

Paleomagnetic results were evaluated using orthogonal vector component plots. Characteristic magnetizations were determined by observing decay of intensity with little or no change of direction over successive cleaning steps. Several samples failed to yield stable end points of demagnetization or became too weak to measure reliably during cleaning to establish a usable direction.

RESULTS AND DISCUSSION

From the upper, massive paleosol, 6 of 9 specimens produced stable endpoints of demagnetization (Table 1), while the lower, laminated paleosol only yielded 4 usable directions out of 13 samples (Table 2).

The mean directions for the two paleosols have statistically similar Fisher precision parameters (k) and 3° to 5° circles of confidence. These mean directions are identical: 355° declination, 47° inclination (Figure 2). Thus, statistical treatment to determine similarity is unnecessary. The revised mean directions are only 2° away from the composite mean direction obtained in the original study.

The similarity of the two mean paleomagnetic directions implies that the paleosols were deposited during the same interval of geomagnetic secular variation. As such, the paleosols are almost certainly penecontemporaneous. Because the conglomerate test insures that the magnetization predates clast deposition and that clast deposition is essentially the same age as the two paleosols, there is an extremely short interval during which remagnetization could have occurred (perhaps, on the order of centuries or less). Therefore, the evidence indicates that the magnetization is stable, and that paleomagnetic correlation on San Salvador Island is a valid stratigraphic tool.

CONCLUSION

A second sampling of the Gaulin Cay paleomagnetic conglomerate test was conducted to increase the sample size in order to verify that the original conclusions based on a small sample are valid. Results of demagnetization experiments have produced 10 additional data points. The revised mean directions for the two paleosols are

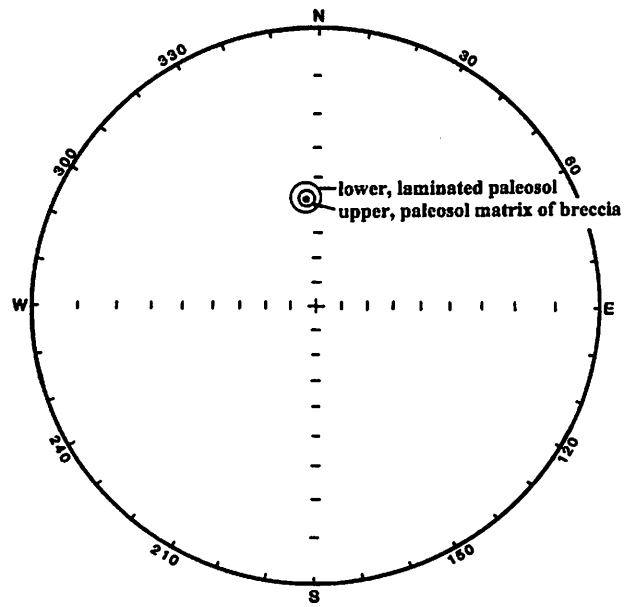

Figure 2. Revised Gaulin Cay paleosol directions. Both paleosol mean directions are identical: 355° declination, 47° inclination. The circles of confidence have radii of 2.9° and 4.9°.

based on sample sizes of 8 and 10. These directions are identical (355° declination, 47° inclination) and confirm that the Gaulin Cay conglomerate test is positive. This strongly suggests that paleomagnetic correlation of paleosols on San Salvador is a valid correlation criterion.

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