(AF) demagnetization decreases with increasing grain size in the range from 0.037 to 0.22 μm but not as rapidly as the coercive force H_c (Table 1). Thus particles throughout this size range display SD-type coercivities. The median demagnetizing fields are 300 to 400 oersteds, and about 3 percent of each 1-oersted TRM is unaffected by an AF of 1000 oersteds.

From the results of the present study, it is apparent that the Néel (*11*) SD theory of TRM cannot be applied to magnetite grains as large as 0.076 μm. In fact, 0.057 μm is probably an upper limit (and 0.035 μm a lower limit) for SD behavior at room temperature. Above the SD threshold, low J_{rs}/J_s values (Table 1) clearly reflect a nonuniform remanent state. The TRM data indicate that Stacey's (*5*) theory of PSD behavior in small MD grains does not apply to grains as small as 0.10 μm, although it may describe 0.22-μm particles adequately. Very likely, in grains as small as 0.1 μm, the width of a domain wall is a substantial fraction of the diameter of the grain. Amar (*17*), for example, has calculated wall widths of 120, 160, 190, and 225 Å in iron particles ($d_0 \cong 150$ Å) having diameters of 200, 400, 600, and 1000 Å, respectively. If similar figures apply to magnetite, the particles in samples 2 through 4 probably do not have a domain structure in the normal sense and Stacey's postulated four-domain structure is almost certainly inapplicable. An obvious first step in constructing a satisfying theory of TRM in such particles would be to determine by direct observation the true magnetic structure in the remanent state, but this is of course extremely difficult in submicroscopic particles.

There exists at present no unified picture which can reconcile the MD-like hysteresis and SD-like TRM of magnetite particles just above the SD threshold (sizes between 0.05 and 0.20 μm). These particles exhibit neither true SD nor PSD behavior. From a purely experimental point of view, however, it is sufficient to note that such particles, if present in significant numbers in an igneous rock, will carry a component of NRM having SD-type stability.

D. J. Dunlop

Geophysics Laboratory, University of Toronto, Toronto 5, Ontario, Canada

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Ratite Eggshells from Lanzarote, Canary Islands

Abstract. *Struthious and aepyornithoid eggshells from Tertiary calcareous sediments on Lanzarote prove the presence, until about 12 million years ago, of large flightless birds. The calcarenite horizon is recognized as an old land surface. Mesozoic sedimentary rocks in the basement of the volcanic islands of Lanzarote and neighboring Fuerteventura indicate that at least part of the Canary Archipelago is underlain by continental crust. Separation of the eastern Canaries from Africa might have been by rifting, and a land connection might still have existed in the lower Pliocene.*

Ratite eggshells from Lanzarote, one of the islands in the northeastern corner of the Canary Archipelago, were recognized by Rothe (*1*) as remains of Miocene to Pliocene ostriches. He found the shells in the calcarenite horizon at the northern tip of the island, in Valle Chico (29°13′08″N, 9°46′40″W) and in Valle Grande (29°12′38″N, 9°46′20″W). The locality is approximately 150 km from the nearest point on the African continent.

A morphological study of the two nearly complete eggshells and 302 shell fragments and an analysis of their pore patterns reveal two kinds of ratite eggshells. They are identified as struthious, that is, belonging to the ostrich genus *Struthio*, and as aepyornithoid, that is, resembling the Malagasy aepyornithid eggs (*2*).

The struthious eggshells from Valle Chico and Valle Grande are on the average 2.0 mm thick. Their pore pattern of irregularly distributed tiny circular pores (Fig. 1) resembles most closely that of the recent *Struthio c. camelus* and the typical Pleistocene "Struthiolithus" eggshells. Also, the size and the shape of the two nearly complete struthious eggshells from Lanzarote (*1*) match those of other fossil and recent ostrich eggs (*3*).

The aepyornithoid eggshells were also found in Valle Chico and Valle Grande. Their pore pattern (Fig. 2) does not resemble that of any of the known struthious eggshells but coincides with those known from extinct *Aepyornis* species of Madagascar (*2*). Since further evidence is needed to prove a possible phylogenetic relationship, the aepyornithoid eggshells from Lanzarote are presently treated as distinct from the family-specific aepyornithid eggshells. The pore pattern of the aepyornithoid shell fragments from Lanzarote is characterized by elongated linear and forked pore grooves, dagger-point pores, and sting pores. They are conspicuously oriented parallel to one another and to the longitudinal axis of the egg. From the material collected so far it is not clear whether the aepyornithoid eggshells belonged to a single species of bird. Their pore pattern varies and covers the same spectrum of interspecific variability typical of the aepyornithid eggshells from Madagascar. Apart from the pieces with a majority of elongated longitudinal pore grooves, the collections also contain fragments in which the short dagger-point and sting pores prevail. Furthermore, the aepyornithoid eggshells are not uniformly thick. Some

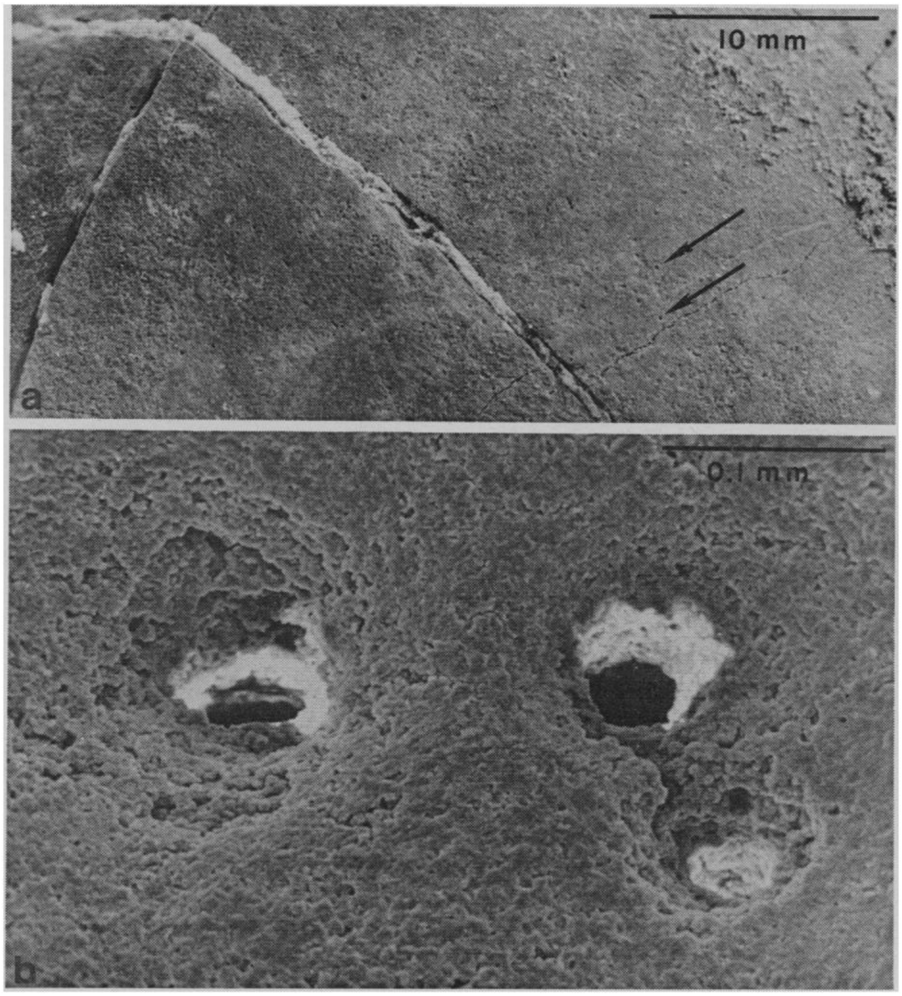

Fig. 1. Pore pattern of struthious eggshells from (a) Valle Grande (light photography) and (b) Valle Chico, Lanzarote (scanning electron micrograph). The arrows indicate the locations of tiny circular pore openings (needle-point pores).

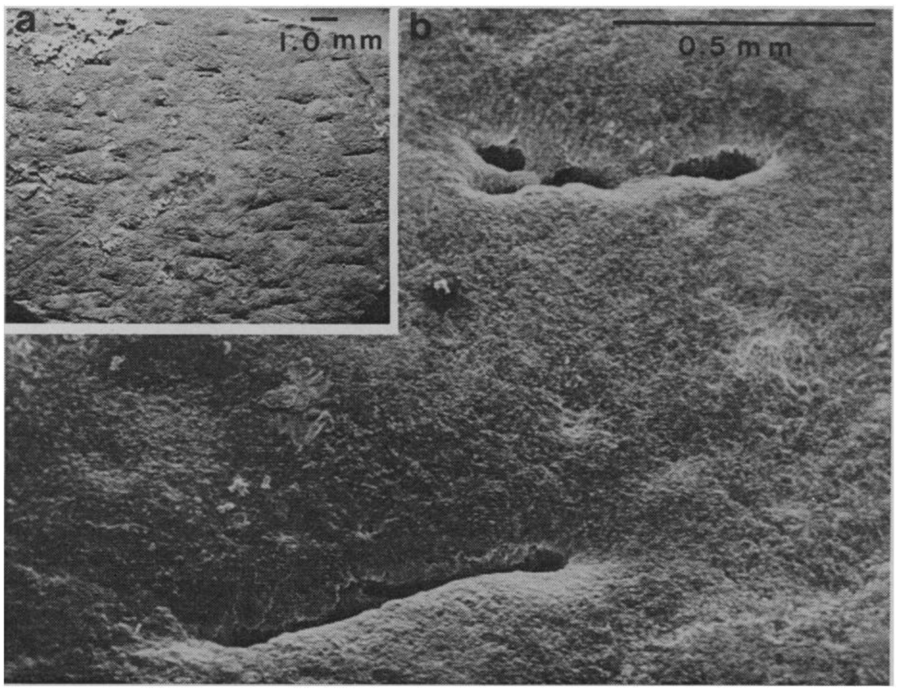

Fig. 2. Pore pattern of aepyornithoid eggshells from Valle Grande, Lanzarote, with linear pore grooves, short dagger-point pores, and sting pores oriented parallel to one another and to the longitudinal axis of the egg. (a) Light photography; (b) scanning electron micrograph.

range from 2.10 to 2.15 mm, others from 2.25 to 2.50 mm, and a third sample contains fragments 2.60 to 2.90 mm thick. This entire range is broader than any known intraspecific modification in the thickness of ratite eggshells.

At present it must be left an open question whether the struthious and aepyornithoid eggshells from the Tertiary sediments of Lanzarote are of the same age. As the layer of sediments is quite thin, remains of different ages might be closely packed.

The eggshell-bearing calcarenite is interbedded within the lower part of a pile about 300 m thick of almost horizontal basaltic lava flows and pyroclastics, which have been dated as 6 to 12 $\times$ 10^6 years old by both K/Ar and paleomagnetic methods (*4*). Because of the paleomorphology of the underlying volcanics, the calcarenite ranges from almost 0 up to 7 m in thickness. It occurs at least around the northern tip of Lanzarote, but much of the material in other parts of the island may already be eroded or is still covered by younger volcanics. The components are mostly marine in origin, Foraminifera, *Lithothamnion*-type algae, and mollusks. The maximum age corresponds to the Torton-Sarmat stage (*5*), which coincides with the age determined by physical methods. The presence of marine fossils does not contradict the assumption of a land surface; many of the Quaternary and quite recent sand dunes on the Canary Islands are composed of a similar material also formed in a marine environment. Abundant remains of several species of terrestrial snails within the Lanzarote calcarenite lend further support to its identification as an old land surface (*5*).

According to the recent evidence at least the eastern Canaries once belonged to the African continent. Although xenoliths of quartz sandstone were found in Tertiary basalts on Lanzarote (*6*), the clue for the basement of the eastern Canaries was detected on neighboring Fuerteventura. Mesozoic sedimentary rocks were compared with similar series from the adjacent African mainland (*7*). The sediments consist of a limestone-marlstone sequence, sandstones and siltstones with shaley intercalations of a probably deepwater turbidite facies, followed by shallow marine limestone with lenticular chert. Foraminifera point to a Cretaceous age for the youngest part of the sequence. A comparison of the entire sequence with sections of borings from the neighboring continent suggests a stratigraphic range from the Jurassic to the Lower Cretaceous. These results, which indicate that the eastern Canaries are underlain by continental crust, are supported by geophysical evidence (*8*).

Rifting parallel to the present continental margin is suggested by tremendous basaltic dikes that cut the Mesozoic sedimentary rocks of Fuerteventura in a north-northeastern direction. The relation between the sedimentary rocks and the dikes indicates that rifting could have started in the Upper Cretaceous. It cannot be stated with absolute certainty that rifting was the mechanism of the separation of the eastern Canaries from the continent. The flightless ratites could have gained access to the Lanzarote area across volcanic land bridges, which would have been destroyed later. As the remains of different kinds of ratites were found on Lanzarote, one can envision successive waves of immigration, most likely with a considerable time gap in between. Thus, the possibility of the birds' access across volcanic land bridges is only slight.

Dietz and Sproll (*9*) add further support to the idea of a continental origin of the eastern Canaries. They suggest that this part of the Canary Islands formed a microcontinent or sialic continental fragment that became detached from the African margin of what is named the "Ifni Gap" in the Africa–North America drift fit. If the opening of this gap happened 200×10^6 years ago, the eastern Canaries block must not have become completely separated from Africa until millions of years later. It could have occurred at a time when the struthious and aepyornithoid birds had established themselves in the Lanzarote region of West Africa.

Dietz and Sproll (*9*) mention a mid-Triassic detachment of the eastern Canaries, but they do not force the issue. They rather suggest that this event might have taken place in the early Cenozoic, associated with the orogeny of the Alps and the creation of the Atlas foldbelt.

Biological and geological evidence brings new validity to the controversial concept of bird distribution and continental drift. It makes it plausible that the isolation of the struthious and aepyornithoid ratites of Lanzarote was the direct result not of the original rifting process between the North American and African continents but of the eventual detachment of the eastern Canaries from the African mainland.

Whether the distribution patterns of birds can be attributed to continental drift has long been a subject of discussion, with seemingly unsatisfactory results. The new and substantial evidence projects the separation of the eastern Canaries from Africa into a period of abundant bird life. One might think that Wolfson's (*10*) ideas on bird migration and its correlation with continental drift can not be rejected on the grounds of a temporal discrepancy between drift and the origin or modification of migration.

The question arises whether the Malagasy elephant birds (Aepyornithiformes) might have experienced an evolutionary development comparable to the one that separated the Lanzarote ratites from their ancestral stock on the African mainland. It is very likely that the aepyornithoids from Lanzarote will eventually become identified as ancestral to the Malagasy ratites, and that both bear a direct relationship to the Asiatic species of aepyornithoid character whose eggshell remains have been found in Punjab and Inner Mongolia (*2*).

E. G. FRANZ SAUER

Zoologisches Forschungsinstitut, and Museum Alexander Koenig, and Universität Bonn, 53 Bonn 1, Germany

PETER ROTHE

Laboratorium für Sedimentforschung, Universität Heidelberg, 69 Heidelberg 1, Germany

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Production of Specific Antibody by Lymphocytes of the Bursa of Fabricius

Abstract. *Lymphocytes in the bursa of chickens have been found to produce hemolytic antibodies to sheep erythrocytes that are introduced into the cloaca. These lymphocytes also react with* Escherichia coli *and form bacterial adherent colonies, but not with gamma streptococci to which they have not been previously exposed. Thymic and splenic lymphocytes do not bind either organism.*

Removal of the bursa of Fabricius from chickens, at or before the time of hatching, interferes with subsequent development of immunological competence, as is shown by decreases in concentration of several classes of serum immunoglobulins and of specific antibody (*1*). The major function ascribed to the bursa, therefore, is that of seeding immunocompetent cells to peripheral sites where they become antibody-producing cells (*2*).

The presence of immunoglobulins G and M has been demonstrated, by immunofluorescent methods, in bursal follicles of mature chickens (*3*); μ and light chains have been found in bursae from 14-day embryos (*4*). In culture in vitro, bursal lymphocytes from 18-day-old embryos synthesize small amounts of IgM (*5*). There is, at best, inconclusive evidence of specific antibody production in or by bursal cells following systemic antigenic challenge (*6*). Neither rosette nor hemolytic plaque formation by bursal cells has been obtained in vitro after parenteral injection of sheep red blood cells (sheep RBC) (*7*). It was also not possible to detect specific antibodies to bovine serum albumin in the bursa after immunization (*8*).

It is enigmatic that lymphoid cells in the bursa actively produce immunoglobulins but not specific antibody, at least not against antigens introduced by the usual methods of immunization. We present evidence here that the bursa produces specific antibodies to sheep RBC's introduced into the cloaca and bursal duct. The bursa is also shown to be a site for antibody production to bacterial antigens that reside in the cloaca.