Table 4 Clay Mineral and Quartz Contents of the Eolian Dusts and some Deep Sea Sediments

	Dusts M1	M2	M3	Deep sea sediments Barbados[1]	C1 (16°01′N; 19°16′W)	C2 (16°02′N; 29°46′W)
Montmorillonite	16	7	4	16	24	14
Illite	46	57	58	41	18	45
Kaolinite	23	23	19	32	46	26
Chlorite	15	13	19	10	12	14
Quartz	20	20	ND	10	15.5	12

ND, Not determined

Clay mineral analyses are for the <2 μm fractions of the dusts and sediments. They were carried out by J. J. Griffin, and are expressed in terms of a 100% clay sample. Quartz analyses are for the total sediment and dust samples. Those for the dusts were made by us, those for the sediments by A. I. Beltagy.

contain a greater percentage of material in the 2–8 μm size class than the sediments, and a smaller percentage in the <2 μm size class. This probably reflects the fact that the collection efficiency of the meshes decreases with decreasing particle size[1].

The mineralogical analyses of several of the dusts are given in Table 3. Quantitatively, the most important minerals in the dusts, and in the land-derived fractions of deep sea sediments, are the clay minerals and quartz. Table 4 shows that the West African dusts contain less kaolinite and more illite than both the deep sea sediments and the average Barbados dust, although the mineralogy of deep sea sediment C2 is very similar to that of the dust M1. The quartz contents of the dusts is greater than that of both the deep sea sediments and the Barbados dust. This is because quartz is present chiefly in the larger size fractions of the West African dust, and much of it will have fallen out by the time the wind mass reaches Barbados.

Although the exposures M1 to M10 were made in the general area of the north-east trade winds, meshes M11 and M12 were exposed in the boundary region between these winds and the westerly winds. Table 2 shows that the mineralogies of the north-east trade and the "boundary" dusts are significantly different, particularly in their content of minor minerals. For example, dolomite is a characteristic mineral in the dust of the north-east trades[1], and although it is present in samples M1 to M10 it is absent from M11 and M12.

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Stratospheric Properties and Bali Dust

NEWELL has drawn attention to an anomalous increase of about 5° C in the stratospheric temperatures in tropical and mid-latitudes in the Southern Hemisphere since 1963. He suggested a causal relationship between this increase and the eruption of Mount Agung in March 1963, which injected large quantities of volcanic material into the stratosphere[2]. I wish to draw attention to several publications which have shown that at the same time a breakdown occurred in the quasi-biennial oscillation. This should be considered before Newell's conclusion can be accepted.

I have proposed tentatively[3] that the temperature anomaly was related to the effects of the Bali volcanic debris or to a change in the nature of the quasi-biennial oscillation. Evidence for the breakdown of the biennial oscillation in total ozone amount and lower stratospheric temperature during this period has been presented by Kulkarni[4] and by Berson[5]. Berson and Kulkarni[6], following Ramanathan[7], have shown that previous changes in phase of the quasi-biennial oscillation have occurred during solar minima, suggesting the breakdown occurring in 1963 may similarly be related.

The question of solar control over the phase changes in the quasi-biennial oscillation is relevant to a discussion of the effects of the Bali injection into the stratosphere. Would an increase in temperature of 5° C have occurred and the temperatures remained above normal for several years if Bali had erupted, say, 5 yr earlier, or was the magnitude of the temperature change related to some combination of the effect of the Bali dust and the change taking place in the phase of the quasi-biennial oscillation ? Alternatively, did the dust injected into the stratosphere trigger the changes in the oscillation ? Until the interaction and magnitude of the two effects can be separated out, it seems somewhat doubtful to equate the 5° C temperature change entirely to the presence of the Bali dust as Newell has done.

It is assumed that the temperature observations reported by Newell are for 2300 h GMT for the Australian stations (approximately 10 a.m. local Australian EST), for night time observations have been taken at (some) Australian stations continuously only since late in 1962. This is unfortunate because an increase in stratospheric temperature due to particle absorption of sunlight might be expected to lead to an enhancement in the diurnal temperature changes at the same height. Diurnal temperature changes at 60 mb in the tropics are of the order of 1°–3° C.

However, examination of the records for US stations in tropical regions have previously failed to show any evidence of a change in the twelve hour temperature differences occurring in 1963 and 1964 (ref. 8). The stations studied included Ascension Island (8° S, 15° W) at the same latitude as Mount Agung. On the other hand, the quasi-biennial oscillation has not been seen in the diurnal temperature differences prior to 1963, nor would it be anticipated that it should occur after this time.

As Newell pointed out, the study of any modification in stratospheric properties due to the presence of volcanic material has important practical applications to the future use of the supersonic transports. The Bali eruption is perhaps the only large eruption for which a reasonable amount of meteorological data is available[9]. It is unfortunate therefore that so little use has been made of such a potentially powerful means of studying stratospheric properties.

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