Possible Destruction of Ozone by Volcanic Material at 50 mbar

VERTICAL ozone distributions over Boulder, Colorado (40° N.), showed a persistent dip in the ozone concentration at 50 mb over the period from March 9 to April 10, 1964. At the middle of the period the dip reached a maximum amplitude of about 50 micro-mbar less than the neighbouring ozone partial pressures, and a 'half-width' of about 5 to 10 mb. The rise in ozone concentration below the 50-mb level was appreciably steeper than the lines of equal mixing ratio, even in the mean of all 23 soundings taken during the above period.

Fig. 1 shows the mean plot of partial pressure of ozone against total pressure for the nine consecutive soundings from March 16 to 27, 1964, over Boulder.

These observations appear to require an 'ozone sink' at 50 mb at the time and place of observation. It is tentatively suggested that such a sink could have been present in the form of a concentrated layer of volcanic dust. Meinel and Meinel^{1,2} reported such dust, attributed to the eruption of Mt. Agung on Bali on March 17, 1963, as late as November 1963. Similar observations have been reported from India, Australia and South Africa.

Mossop³ gives estimates of mean concentration and diameter of samples collected over Australia, while Bigg (personal communication) has furnished photographs showing patches of volcanic dust as far south as 41° S. and having a vortical thickness of the order of one kilometre or less.

From the persistence of the 'ozone hole' over Boulder and the winds then prevailing at the 50-mb level, which were very light, it is estimated that the patch of dust must have extended over horizontal distances of the order of a few thousand kilometres. Confirmation from stations in the United States Air Force ozone-sonde network gives support to this picture. A similar 'ozone hole' was found in soundings from Fort Collins, Colorado, on March 18 and March 25; from Albuquerque, New Mexico, on March 18 and April 8; and from Bedford, Massachusetts, on April 1 and April 2.

A model of such a dust layer has been drawn up and the resulting ozone profile computed. This model requires a thin layer having a vertical mixing coefficient more than an order of magnitude less than current estimates of the mean value. On the model chosen a destruction rate of one ozone molecule in every 3.5×10^7 per sec is required to give rise to the observed ozone profile. As the mass of ozone per unit volume at 50 mb is several orders of magnitude greater than the estimated mass of dust per unit volume, such destruction must be catalytic in nature, most likely due to the adsorption of ozone molecules on the surface of the dust particles with subsequent decomposition on collision with a second ozone molecule.

Fig. 1. Mean of nine consecutive ozone soundings, March 16–17, 1964

In conclusion, it is emphasized that this model is put forward to explain a very particular event and does not necessarily imply that dust is normally present in sufficient concentration to appreciably affect the ozone distribution at these levels. Nevertheless, the implications regarding circulation and vertical eddy diffusion require further investigation, as does the possibility that a concentration mechanism operated to produce the high dust concentrations required here (and observed over Australia).

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¹ Meinel, M. P., and Meinel, A. B., *Science*, **142**, 582 (1963).

² Meinel, M. P., and Meinel, A. B., *Nature*, **201**, 657 (1964).

³ Mossop, S. C., *Nature*, **203**, 824 (1964).

METALLURGY

Effects of Silver and Two-step Ageing Treatments on a Weldable Alloy of Aluminium, Zinc and Magnesium

POLMEAR and co-workers¹⁻³ have shown that small additions of silver to Al-Zn-Mg alloys can bring about increases in strength, and, by retarding over-ageing, allow alloys to be aged at higher temperatures. When silver was added to 'DTD 683' (ref. 3) the increase in hardness at ageing temperatures up to 135° C was small, the main advantage being that high hardness levels were maintained when ageing at temperatures up to 180° C.

Taylor⁴ has shown that to produce the highest mechanical properties in a reasonably short time in weldable Al-Zn-Mg alloys a 2-step ageing treatment is required. The alloy is first aged at a temperature below 100° C, and then aged at or above 120° C, when reversion is followed by rapid ageing to give higher strengths than could be obtained by ageing directly at the higher ageing temperature. Taylor's work does not show whether the use of 2-step ageing treatments allows high hardness levels to be maintained at temperatures much more than 135° C. The use of high ageing temperatures could be an advantage in weldable Al-Zn-Mg alloys, since the heat-affected zone should be narrower the higher the ageing temperature.

Experiments to evaluate the effect of silver and the effect of 2-step ageing treatments on commercially produced weldable Al-Zn-Mg alloys have been carried out on two alloys containing nominally 5.0 per cent (weight) Zn, 1.3 per cent Mg, 0.1 per cent Cr, and 0.2 per cent Mn, one of which contained an addition of 0.45 per cent Ag. In the first instance hardness has been used as a measure of strength, though it is recognized that hardness is not a fundamental property.

Specimens of both alloys were solution-treated at 460° C for 30 min and water quenched. For each alloy specimens were first aged for 7 days at 20° C, 7 days at 70° C and 7 days at 100° C, before being aged at 120° C, 140° C, 160° C and 180° C. In addition some specimens were aged directly at the final ageing temperatures without a preliminary low-temperature age. The initial low-temperature ageing treatments were chosen arbitrarily.

In the silver-free alloy, 2-step ageing treatments resulted in higher peak hardness values at all ageing temperatures between 120° and 180° C, the effect being more marked the higher the final ageing temperature. The best results were obtained when the first ageing was for 7 days at 70° C.