Mount Unzen rumbles on

SIR — Last June's explosive eruption of Mount Unzen stirred up considerable controversy about the ability of Japanese authorities to forecast its behaviour. Although out of the headlines for the past 10 months, Unzen has continued to extrude a large lava dome that looms above the city of Shimabara, shedding rockfalls, pyroclastic flows and mudflows, with no signs of abating. This activity has been monitored more closely than any dome-producing eruption except that of Mount St Helens in the 1980s. A comparison of the two eruptions suggests that the dangers at Unzen are likely to continue for several years.

Although superficially similar, the two eruptions exhibited markedly different styles. The main St Helens dome appeared in October 1980 after most of the explosive activity had ceased, growing slowly and intermittently during October 1986. Throughout Unzen's first year, pyroclastic flows have formed repeatedly by collapse of the dome's oversteepened front, with the dome itself enlarging continuously and vigorously, growing more in 10 months than the St Helens dome did in 6 years. As the St Helens dome grew taller its weight caused an increase in the repose intervals between eruptive pulses, reflecting a delicate balance between the magmatic system and local conditions. Unzen has yet to show any such sensitivity. Finally, the St Helens dome exhibited two lava textures, smooth and scoriaceous, caused in part by variations in dissolved water content. Unzen's lava has been uniformly nonvesicular, indicating a more homogeneous magma source.

A hallmark of the St Helens monitoring programme was repeated collection of high-resolution digital topographic data, allowing more accurate calculations of dome volume than previously possible[1,2]. Plots of dome growth rate versus time revealed a steady power-law decrease superimposed on episodic emergence of lava. The long-term decline suggested depletion of a relatively small magma source and cyclic behaviour was consistent with a regenerative eruptive process such as crystallization-induced volatile enrichment[3]. Volumetric measurements at Unzen show steady, rapid production of texturally uniform lava[4], implying a considerably larger source capable of sustaining a much longer eruption. For comparison, active domes in Guatemala and Kamchatka have grown at rates similar to Unzen's since 1922 and 1956, respectively.

At present, the magnitude of Unzen's pyroclastic activity seems to depend more on the volume of rock-falls than on chemical variations in the magma[4]. Based on recent inspection of the oversteepened dome face, rock-falls two to three times larger than those yet seen are possible. It would thus be prudent for civil authorities to maintain the current evacuation zones as long as the present extrusion rate continues. Well before Unzen shuts down and life in Shimabara can return to normal, this rate should drop off, accompanied by intermittent effusion of lava with more variable water content, vesicularity and explosivity. Early detection of such trends will require continued funding for a monitoring programme that includes repeated collection of topographic data and photographic documentation.

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1. Swanson, D. A. & Holcomb, R. T. *IAVCEI Proc. Volcan.* **2**, 1–24 (1990).
2. Fink, J. H. *et al. Nature* **348**, 435–437 (1990).
3. Cashman, K. V. *Bull. Volcan.* **50**, 194–209 (1988).
4. Nakada, S. & Fujii, T. *J. Volcan. geotherm. Res.* (in the press).

Balloon response explanation?

SIR — The remarkable photograph (S. V. Boletzky *et al. Nature* **356**, 199; 1992) of a cirrate octopod hovering at a water depth of 2.88 metres off Lifou Island in the southwestern Pacific raises the question of why the animal prefers transition into a pumpkin shape as a defence mechanism.

The answer could lie in the large 'acoustic size' gained by transition into a spherical shape compared to the normal 'flat' (low acoustic reflective) shape. Marine predators often use high-frequency sound pulses for ranging and location of prey. The sudden appearance of a very large acoustically reflecting object in mid-water nearby would undoubtedly confuse and frighten the predator. I therefore suggest that the octopod 'ballooning' is an effective underwater defence mechanism.

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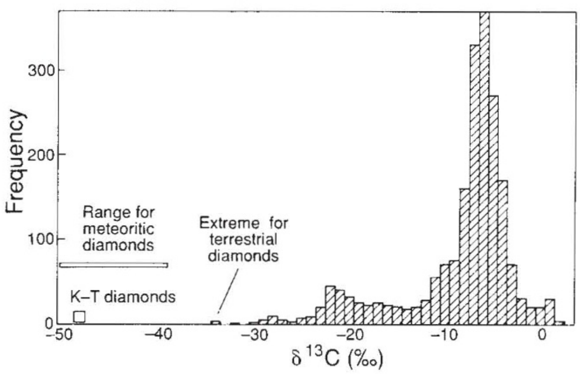
Diamonds at the K/T boundary

SIR — In our recent report[1] of our discovery of nanometre-sized diamonds at the Cretaceous/Tertiary (K/T) boundary, we suggested that the diamonds may have come from the meteorite that is widely thought to have struck the Earth at that time. We pointed out[1], however, that we could not exclude the possibility that the diamonds were formed by shock metamorphism of carbonaceous target rocks. We have now measured the carbon-isotope ratio of the diamonds and can confirm that they are of extraterrestrial origin.

Galimov[2] summarized the known carbon-isotope ratios for terrestrial diamonds. Although diamonds from different sources differ in $\delta^{13}C$, the mean value is roughly –7‰, with the extreme value –34‰. Nanometre-sized diamonds from C2 carbonaceous chondritic meteorites have $\delta^{13}C$ values between –38‰ and –50‰ (ref.3). Mass spectrometry of a freshly prepared sample of diamonds from the K/T boundary layer of Alberta gave a $\delta^{13}C$ value of –48‰. This is incompatible with a terrestrial origin, or with shock formation from carbonate on the impact of a bolide. Such a value is, however, compatible with that found in C2 carbonaceous chondritic meteorites[3] and, moreover, seems closer to the general C^{13}/C^{12} ratio of the interstellar medium than to the terrestrial norm of 1:89 (ref. 4).



Frequency histogram of $\delta^{13}C$ (‰) in terrestrial diamonds (from ref. 2) with the range of values reported in meteorites and the value found in diamonds from the K/T boundary.

The notion that these diamonds are of extraterrestrial origin is reinforced by the discovery of chromite, spinel and silicon carbide grains in the K/T boundary, although these too are absent from samples taken 2 cm above or below the boundary; all these species are abundant in C2 carbonaceous chondritic meteorites[5].

It is perhaps worth noting that the presence of free diamonds and of silicon carbide may indicate that these meteorites, and the bolide whose impact is responsible for the K/T event, were formed under conditions in which the O/C ratio was less than 1,