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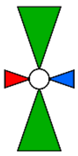

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will be left, and this will form a long tube or tunnel running along the centre of the flow, sometimes for many kilometres. [See Fig. 4] and [see Fig. 5]. Such lava tunnels are quite common, and they can be most useful. At one time, there was one high up on Etna which served as a convenient overnight refuge for geologists watching activity in the crater. It was at a height of nearly 3,000 metres & the air outside was well below freezing, but the lava tunnel was in an area of recent activity, and as a result it boasted beautiful underfloor heating. Near the entrance the temperature was comfortable, but further in it rose progressively until it was intolerable. Brewing up was easy - all that had to be done was to shift a few boulders to reach a hot spot lower down, and pop a billy-can of snow into the hole. All things have drawbacks, however, and the sulphurous fumes wafting down from the crater were distinctly smelly, and the occupants of the tunnel awoke in the morning with headaches and mouths that tasted like the bottom of a parrot's cage. Lavas which are fluid enough to produce tunnels also produce a number of other oddities. Sometimes, in the middle of a flow, or else at the small mouths or boccas from which the flows emerge, gas venting from the lava flings small glowing gobbets of it short distances up into the air. These fall back to earth as soft, squishy pancakes which pile up closely round the vent, soon enclosing it in a kind of chimney or hornito. These hornitos, which are also known rather aptly as driblet cones, go on growing as long as there is both gas and lava to feed them, and they may reach a height of many metres. The rate of flow of gas blowing off through these vents is often surprisingly fast. It's sometimes possible to approach them closely enough to stick a device like an anemometer, or wind speed gauge, into the gas jet, and by doing this, supersonic speeds have been recorded. Unfortunately, though, the gas is often extremely hot, probably over 800 degrees C, so the instrument that comes out of the jet is often only a sad relic of the instrument that went in. Sometimes it doesn't come out... Submarine Basalt Lava Flows It may seem self-evident that submarine lava flows should be different from those formed on land, and that their formation should be accompanied by **violent interaction between sea water and hot lava**. In some cases, where large aa lavas flow from land into the sea, this is true, and

great quantities of steam

are generated, while the lava is broken up into small glassy fragments which pile up in thick heaps at the front of the flow. A lava flow originating on land can advance considerable distances into the sea in this way, building up a kind of delta of fragmental material on to which the flow proper can advance. Surprisingly, though, small pahoehoe lavas can pour into the sea with as little disturbance as cream poured into coffee, there is **a little steam**, but little else. This unexpected situation seems to arise because, when the molten lava enters the water, a layer of steam bubbles forms around it immediately, and this forms an effective insulating blanket, so that no violent interaction is possible. The same is true of lava flows which are actually extruded under water. These are common enough, since, as has already been

	mentioned, a large proportion of the world's volcanoes are situated in or below the oceans. Unfortunately it is not easy - for obvious reasons - to study modern submarine lava flows in their proper environment. The most convenient way to study flows of this sort is to look at old examples which have been brought up above sea level by earth movements of one kind or another, and which have been subsequently cut through by erosion and exposed in clean, dry cliff sections. Their appearance in such an exposure is extremely distinctive. Instead of a single thick unit, like a land-based basalt, a submarine flow consists of a multitude of little packets of lava, commonly about one metre across, each with a fine-grained, glassy skin, and these packets are piled on top of one another, sometimes in thicknesses of hundreds of metres or more. These packets are properly called pillows, and the lavas pillow lavas. It is clear that the skin of each pillow must originally have been fairly flexible, since the base of each pillow characteristically sags into the gap between the ones below it. For many years there was much debate about how pillow lavas formed. One idea was that they roll downslope from the submarine volcanic vent like plastic bags full of water, before piling up on top of one another; another was that they whizzed along the sea bed, supported by a cushion of collapsing steam bubbles; while a third suggested that 'pillows' aren't separate entities at all, but long, worm-like tubes whose thickness varies along their length. It also used to be thought that pillow lavas could form only at great depths below the surface. In the last few years our understanding of pillow lavas has advanced dramatically, due almost entirely to some remarkable observations made by diver-geologists of pillow