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PSEUDOKARST: DEFINITION AND TYPES

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ABSTRACT

Pseudokarst is a karst morphology produced by non-solutional processes. It does not include solutional features in non-limestone rocks which are here included in true karst. Pseudokarst processes include a variety of mechanical agencies in which material is removed in the solid state, together with effects resulting from change of phase and removal of liquid material. Gaseous removal (ablation) is a minor effect in snow and ice caves.

DEFINITION

To define Pseudokarst it is first necessary to define what is meant by true karst. Usual definitions of karst are based on both the nature of the landforms and the process that produces it. For example Monroe (1970) defines<u>karst</u> as ”A terrain, generally underlain by limestone, in which the topography is chiefly formed by the dissolving of rock, and which is commonly characterised by Karren, closed depressions, subterranean drainage, and caves”. Some authors (e.g. Sweeting, 1972, p.306) would restrict the term karst to limestone terrains however I prefer to avoid naming the rock type involved and feel that it is the act of solution which is the main criteria for the definition.

For the purposes of this discussion it is convenient to distinguish between the two parts of the conventional definitions of karst. The first concept is of <u>morphological karst</u> which is the landforms characterised by Karren etc, (see above though not all these features need he present in any particular case. The second concept is the <u>karst process</u>, i.e. solution. We can then define <u>Pseudokarst</u> as a karst morphology produced by some process other than solution.

There are a number of pseudokarst processes which can operate. These generally have in common the removal of material from beneath the land surface leading to the production of cavities and thence to surface depressions, underground drainage, etc. Solution can assist pseudokarst processes and vice versa so the distinction between true karst and pseudokarst should be made on the basis of the dominant process.

TYPES OF PSEUDOKARST

(A) Non-limestone karst

Using my definition, true karst can occur in lithologies other than limestone provided that solution is the dominant process. As such features are sometimes referred to as ”pseudokarst” I will briefly mention them here (see also Table 1). They include solutional forms on gypsum and halite, known as salt karst (Fairbridge, 1968 a); Karren formed on igneous rocks, a feature best seen in

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tropical climates (e.g. Wall & Wilford, 1966; Dragovich, 1968); in Tasmania a cave produced by solution of secondary minerals in an alteration zone of a dolerite, described by Hale & Spry (1964); volcano-karst, a form produced when labile minerals in newly erupted volcanic ashes are rapidly dissolved to produce weird sculpturing forms (Fairbridge, 1968 b, and Bourke in this volume); and laterite-karst, where silicate minerals are removed in solution from within a deep weathering profile (Grimes, 1974). (Laterite-karst is distinct from the laterite caves in West Australia described by Lefroy & Lake (1972) which appear to be a piping phenomena).

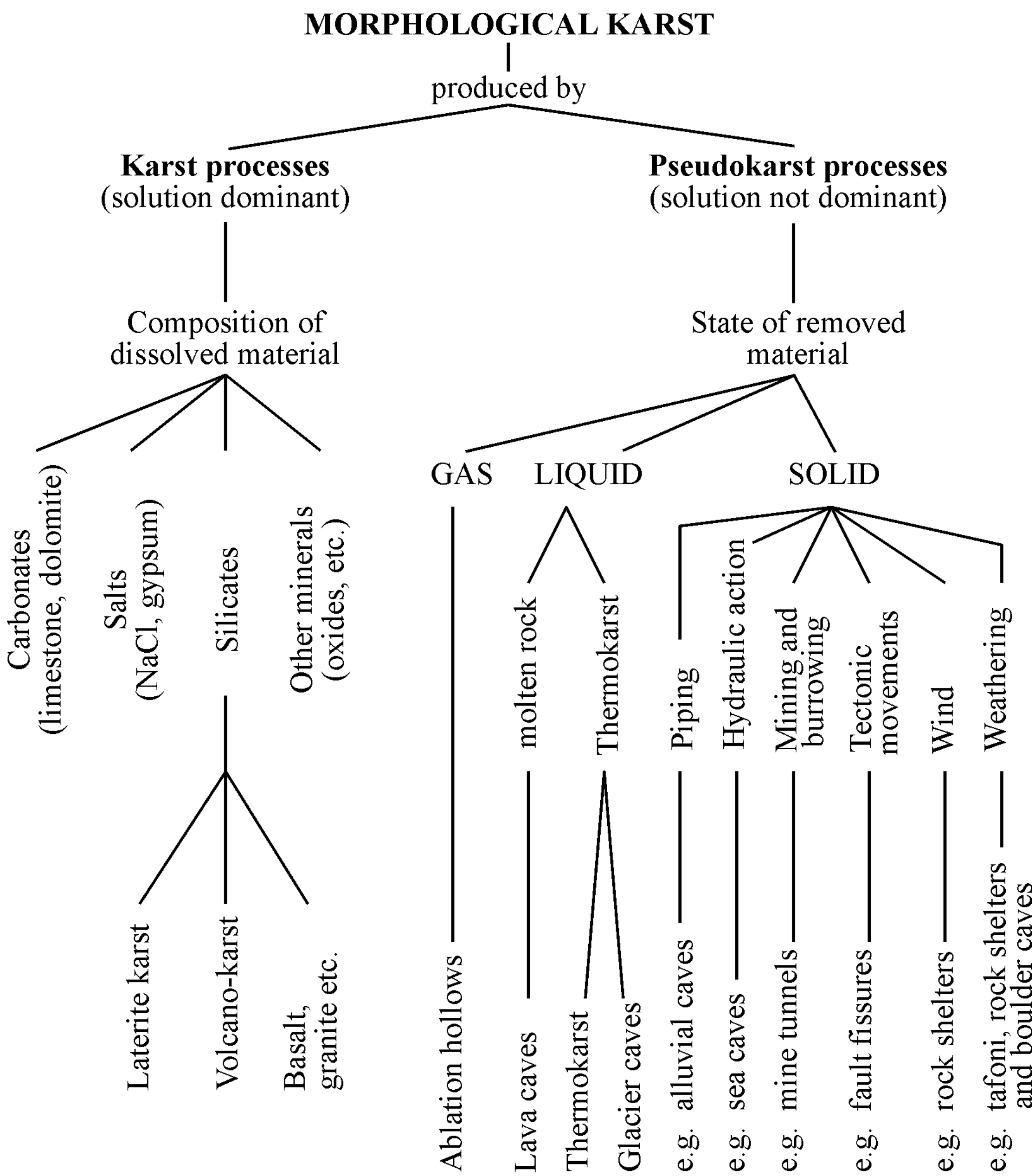

Table 1. Classification of Karst and Pseudokarst

(B) True pseudokarst

The different types of pseudokarst are grouped here according to the phase in which the material is removed (see Table 1):

(i) Solid phase removal.
The greatest variety of pseudokarsts result from the removal of solid material. Piping is a form of soil erosion which can also occur in poorly consolidated deposits. The process is one in which clay particles are removed in suspension by groundwater percolating through cracks or pore spaces in the sediment. In conjunction with this headward sapping occurs at springs. Once underground tunnels are produced by these processes they can be enlarged by the normal corrasive action of streams flowing through them. Fletcher et al (1954) postulated five conditions for the development of piping: (1) a source of water, (2) a surface infiltration rate which exceeds the permeability rate of some subsoil layer, (3) the existence of an erodible layer just above the retarding layer, (4) the water above the retarding layer must have a hydraulic gradient along which it can flow laterally, and (5) there must be an outlet for the lateral flow. The process is facilitated by the presence of swelling clay minerals and by a high exchangeable sodium potential. Piping can result in intricate forms of morphological karst, including caves, underground streams, dolines, etc. (Parker et al, 1964; Parker, 1968; Mears, 1968; Feininger, 1969). The process is characterised by its rapidity when compared with solution karst; Parker et al (op cit) quote rates of 2,700 cu.ft. per year for enlargement of Officer’s Cave, U.S.A.. Some authors (e.g. Khobzi, 1972, and the Cave Summary sheets produced by the A.S.F.) use ”suffosion” as a synonym for piping. This is not valid as suffosion is a periglacial phenomenon (see Fairbridge, 1968 c).

Some Australasian examples of piping caves will be described by Bourke and by Shannon elsewhere in this volume. A good local example is the Flagstone Creek Caves (Gillieson, 1971).

Sea Caves result from the combined hydraulic action of waves and the pressure of compressed air, aided by salt spray weathering. Dolines can form above the caves. A large number of sea caves in N.S.W. have been described in recent years and Toomer & Welch will be summarising these studies elsewhere in this symposium.

The mechanical removal of material from animal burrows or by human mining activities could be considered as a form of pseudokarst. Mine tunnels are analogous in form to natural caves and disused mines are often occupied by bats and other cave dwelling species. They can develop speleothem deposits if conditions are suitable and these may include some of uncommon mineralogy in the case of metalliferous mines. Some beautiful stalactites of malachite and azurite have formed in disused parts of the Mt. Isa mines. Subsidence areas and dolines can form above old mine workings.

Some other forms are fault fissures resulting from tectonic movements, and the formation of rock shelters and small caves by weathering or wind erosion. Weathering can combine with piping of the resultant clay material to enlarge joints in granite and produce an underground drainage, e.g. the Labertouche Cave in Victoria (Ollier, 1965) and the Underground River at Wyberba, Qld., (Pound, 1971).

(ii) Liquid phase removal.
The most common form in this group is the formation of lava tunnels by the draining of molten lava from within a solidifying flow. Ollier & Brown (1965) have described in some detail the process which formed the Victorian lava caves. In these the lava solidified in laminae separated by still molten material which then became segregated into discrete cylindrical tubes. These were at first filled with molten rock and capable of remelting their walls and moving uphill for short distances under hydrostatic pressure. If the tube were then drained a lava cave would result and sagging or collapse of the roof could

form surface depressions. Hatheway (1971) presents a similar theory but considers that the mobile cylinders of liquid lava originate at the toe of the flow and develop backwards up the flow to its source. Greeley (1971, 1972) has observed the formation of tunnels by the crusting over of lava channels on the surface of an active flow in Hawaii. In Queensland the best known lava tunnels are in the Mt. Surprise area (Watt, 1972; White, 1965, pp. 91-101). The lava cave at Bunya Mountains may be a weathering feature rather than a true lava tunnel (Graham, 1971).

Melting of ice and snow produces several types of pseudokarst. Meltwater caves in snow banks or in glaciers are of most interest to speleologists. Glacier caves can reach 2.5 km length (Halliday & Anderson, 1970). Local examples have been described from the Snowy Mountains by Halbert & Halbert (1972) and from New Zealand (Shannon, 1972). An interesting form is the summit firn cave of Mt. Rainier, U.S.A., in which the melting is mainly due to heat from volcanic activity (Kiver & Mumma, 1971).

In arctic areas seasonal thawing of frozen ground results in a terrain known as thermokarst (Dylik, 1968; Anderson & Hussy, 1963) which includes pits, dry gullies, small hummocks and closed depressions. The processes involved include subsurface mudflows which erupt at the surface as mud volcanoes and this is the preferred use of the term ”suffosion” (Fairbridge, 1968 c).

(iii) Gaseous removal.
This is a theoretical possibility, as in the ablation of snow and ice, but I don’t know of any examples where this is the dominant process. Ablation could have formed the steam cups and fluting of the ice walls of the caves on Mt. Rainier (Kiver 5 Mumma, op cit).

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