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URANIFEROUS SURFICIAL DEPOSITS

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PRETORIA
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CONTENTS

LIST OF FIGURES

LIST OF TABLES

SAMEVATTING

As gevolg van die ontdekking van uraan in oppervlakafsettings van Tersiêre en Resente ouderdom, in Australië en Suidelike Afrika, word toenemende aandag aan die ligging en 'n begrip van die ontstaan van hierdie afsettings verleen.

In hierdie referaat word die huidige omskrywings en terminologie bespreek en word 'n klassifikasiestelsel vir hierdie afsettings aan die hand ge= doen. Om 'n mate van duidelikheid te verkry, word daar tot die gevolg= trekking gekom dat die terme kalkreet, gipskreet en dolokreet nie ge= bruik moet word om die uraanhoudende valleistiloewer-afsettings van Suidelike Afrika en Australië te beskryf nie.

ABSTRACT

As a result of the discovery of uranium in surficial deposits of Tertiary to Recent age, in Australia and Southern Africa, increasing attention is being paid to the location and understanding of the genesis of these deposits.

The paper discusses the definitions and terminology currently in use and a classification of these deposits is presented. It is concluded that in order to obtain a measure of clarity, the terms calcrete, gypcrete and dolocrete should not be used to describe the uraniferous valley-fill deposits of Southern Africa and Australia.

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1. INTRODUCTION

Subsequent to the discovery of the Yeelirrie deposit in Australia in 1972, the so-called "calcrete" uranium occurrences are continuing to receive increasing attention. Numerous similar deposits have been located in various parts of the world and a number of potential areas remain to be investigated.

The deposits located to date vary considerably in size and there seems little doubt that some of the larger deposits will, in time to come, make a significant contribution to the uranium resource inventory of certain countries. Due to the surficial nature of these deposits and relatively cheap mining and extraction processes envisaged, it is considered likely that many smaller deposits will become viable mining propositions either collectively or individually within the foreseeable future.

Evaluation of the available literature shows that some confusion has arisen as to the use of the term "calcrete" when describing non-pedogenic fluviatile sediments which have been calcified to a lesser or greater degree. It is felt that a useful purpose could be served by proposing a classification system which may go some way towards more clearly defining the terminology currently in use.

2. DEFINITIONS AND TERMINOLOGY

Uraniferous surficial deposits may be broadly defined as uraniferous sediments usually of Tertiary to Recent age which have not been sub=jected to deep burial and may or may not have been calcified to some degree.

In terms of the original definition (Lampagh in Premoli, 1976), calcrete should be defined as pedogenic deposits in which the main constituents are carbonates. This definition would in the same sense apply to the terms dolocrete and gypcrete. It is therefore unfortunate that the terms "calcrete" or "valley calcrete" (Carlisle *et al*, 1978) have been used to define Tertiary to Recent fluviatile sediments ranging from boulder beds to silts which, in some South West Africa/Namibian examples, contain between 5 % and 50 % $CaCO_3$, and as much as 90 % total carbonate at Yeelirrie in Australia (Western Mining Corp. Ltd, 1974).

This misnomer has no doubt arisen due to the fact that many fluviatile sediments are highly calcified and have interbedded, or are overlain by pedogenic deposits which could well be described as calcretes, dolocretes or gypcretes.

TABLE I : CLASSIFICATION OF SURFICIAL URANIUM DEPOSITS

Surficial Uranium Deposits

Fluviatile	Lacustrine/Playa	Pedogenic
(see Table II)	(see Table III)	(see Table IV)

A proposed system of classification of surficial uranium deposits, illustrated in Table I, is submitted for discussion. The secondary classifications are to be found in Tables II to IV. From this classi= fication three main groupings, namely Fluviatile, Lacustrine/Playa and Pedogenic, are recognised and the terms calcrete, dolocrete and gypcrete are used as originally defined to describe the pedogenic deposits only.

It will also be noticed that economically important calcareous and gypsiferous arkoses and sandstones referred to by Carlisle *et al* (1978) as valley calcretes and by Hambleton-Jones (1976) simply as calcretes are termed valley-fill sediments in Table II. They could be prefixed by the terms calcareous, dolomitic or gypsiferous.

This sort of classification is not entirely definitive, for within a surficial deposit there may well be two or more types in juxtaposition, separated by a transitional zone. A problem also arises regarding the process of pedogenesis and the question arises of when a fluviatile or lacustrinal sediment transform to a soil and hence a calcrete in terms of Lampagh's definition. These problem areas may tend to confuse the absolute meanings of the suggested terminology but are regarded as sufficiently objective in terms of known field relationships.

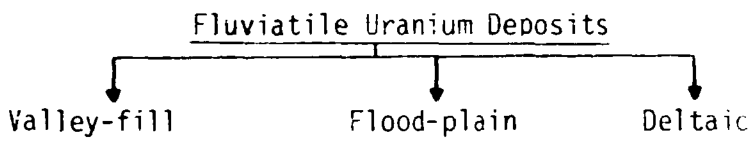
A brief description outlining the essential features of each type and illustrating the proposed concepts, is presented in Section 3.

3. TYPES OF SURFICIAL URANIUM DEPOSITS

3.1 Fluviatile

Uraniferous fluviatile sediments of Tertiary to Recent age classified as valley-fill, flood plain or deltaic deposits are shown in Table II. As indicated by the terminology the valley-fill sediments occur in areas of steeper gradient while the flood plain or deltaic deposits form under lower energy regime conditions. The gradation from one

TABLE II : CLASSIFICATION OF FLUVIATILE URANIUM DEPOSITS



type to the next is naturally transitional and ill-defined. The fill material is derived largely from the weathering of basement rocks and from aeolian sands followed by lateral fluviatile transport. The concepts of the proposed nomenclature are represented diagramatically in Fig. 1.

3.1.1 Valley-fill

The valley-fill uranium deposits have the greatest economic potential of all the surficial deposits so far discovered. They have variously been described by Western Mining Corp. (1975), Hambleton-Jones (1976), Mann (1974), Mann & Deutscher (1978a,b), Butt *et al* (1977), Carlisle *et al* (1978), Premoli (1976) and Langford (1974). They are known to occur in Western Australia, South West Africa/Namibia, South Africa and Somalia. The most noteworthy occurrences are the Langer Heinrich and Tubas in South West Africa/Namibia, Yeelirrie in Australia and Dirks se Kop and Kammasoas in the Northwestern Cape in South Africa.

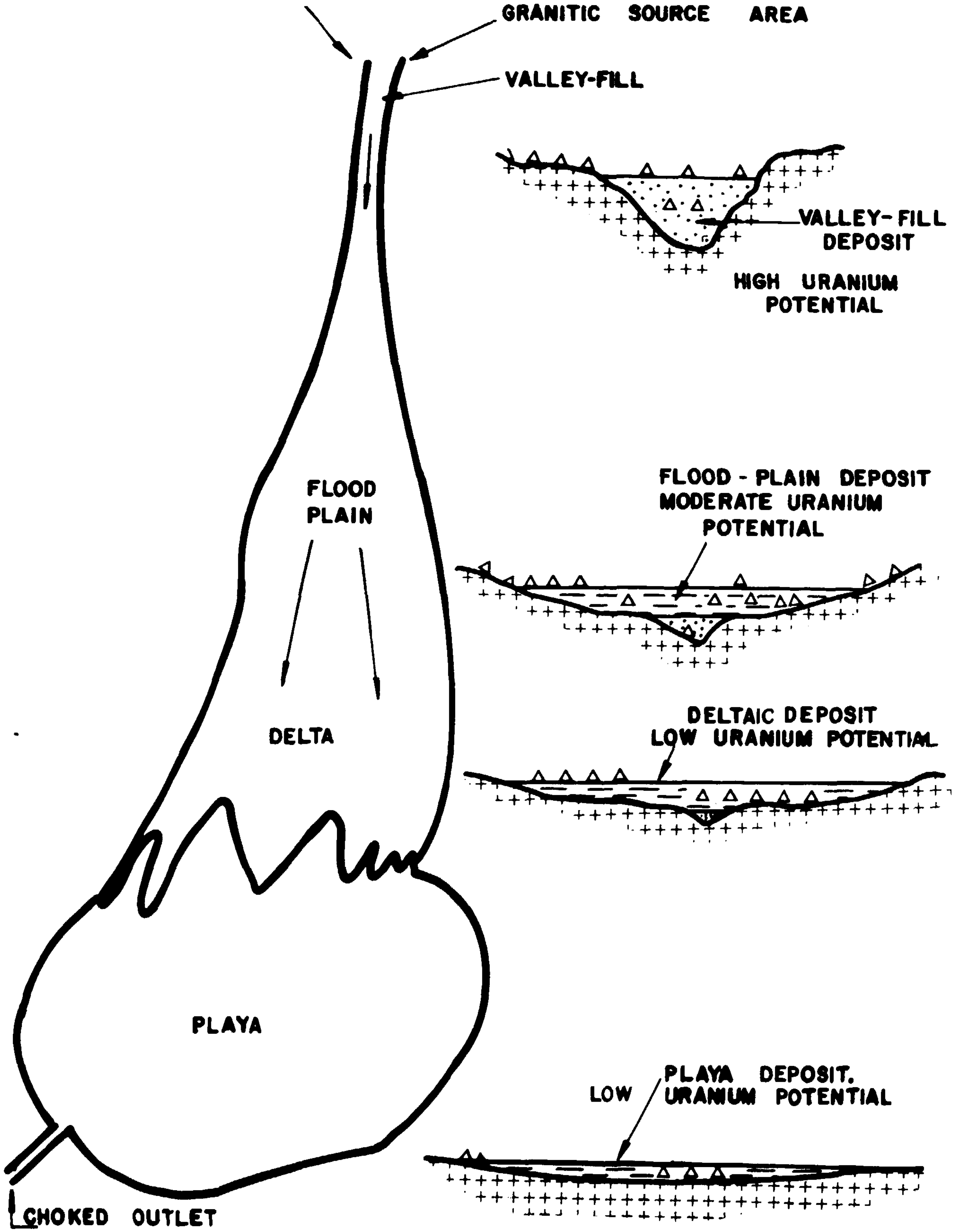


Fig. 1 : Schematic presentation of the location of Valley-fill, Flood plain, Deltaic and Playa deposits within a drainage system. Intercolated pedogenic deposits (indicated thus, Λ) representing period of quiescence are dispersed throughout the succession.

In the Namib Desert of South West Africa/Namibia the fluviatile sedi= ments are typically breccia conglomerate, conglomerate, gravel, grit, sand, silt and clay which are all of a generally arkosic composition with some of aeolian derivation. Deposition of these sediments fre= quently took place under flash-flood conditions in a high energy regime. The upper sedimentary layers, irrespective of their texture, have been cemented epigenetically by calcite, gypsum or dolomite. Lower down in the sequence the carbonate or gypsum content decreases.

In the Northwestern Cape of South Africa the deposits occur in a mixture of both reddish to brown fluviatile and reworked aeolian sediments, being sandy in texture. Gypsum and, to a lesser extent, calcite, con= stitute the cement.

Yeelirrie differs from the Southern African types in that the main carbonate rich zone is porcellaneous in texture and contains as little as 10 % fine-grained detrital or aeolian material. Below this zone the grain sizes of the detrital fraction increase to that of a grit of arkosic composition with an accompanying decrease in carbonate content. Dolomite with subordinate calcite is the main constituent of the cement.

Uranium occurs usually as carnotite and is an important accessory mineral of the epigenetic portion of the sediment occurring as coatings, vugg-fills, concretions and veins.

The drainage patterns of the type areas described above are generally internal in that no or very little water reaches major rivers or the ocean as it tends to disappear rapidly within the alluvium. Tilting, loss of erosional power and deposition at barriers have tended to choke the valleys. In Western Australia river channels are terminated in some areas by salt lakes but this feature is not characteristic of the Northwestern Cape and South West Africa/Namibia. In the latter instance, for example in the Tumas River, water can travel many tens of kilometres before gradually disappearing into the sand.

3.1.2 Flood-plain

Flood plain deposits are essentially sheet-like; they may either overlie or occur downstream of the valley-fill deposits. Their composition is essentially the same as that of valley-fill deposits but as the name implies, they may have considerable lateral extent but may vary in thickness from a thin veneer of sediment over basement rocks to extensive deposits tens of metres in thickness. Much of the material is obviously derived from the reworking of valley-fill sediments.

3.1.3 Deltaic

Deltaic deposits form where the flood-plain or valley-fill deposits enter a lacustrinal or playa environment. The composition is essentially the same as that of the flood-plain type. The sediment is, however, finer grained and more argillaceous and often contains interbedded lacustrinal deposits which are indicative of playas or pans forming in periods of quiescence.

3.2 Lacustrine/Playa

Uraniferous playa deposits have been located in South Africa (Richards, 1975) and Australia (Mann & Deutscher, 1978a). No deposits of this type are known to contain sufficient mineralisation to constitute a viable proposition under current conditions. It is nevertheless important to categorise these deposits for future reference.

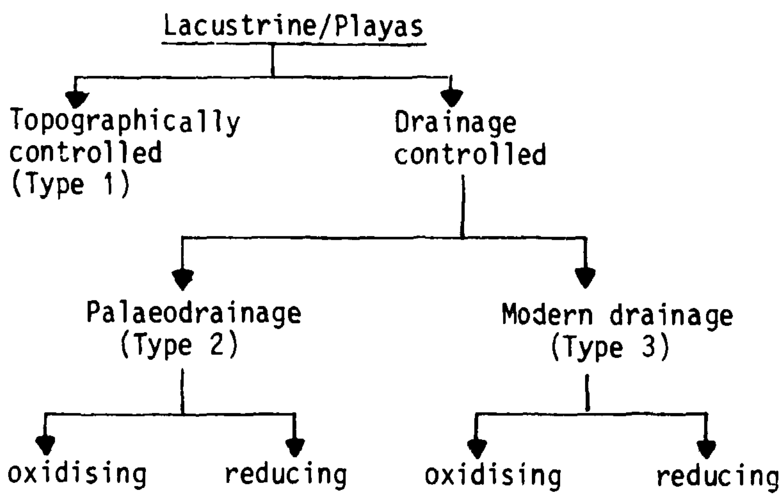
The terminology relating to "dried lakes" varies in different parts of the world but the term "playa" is the sack term in the English speaking world for those flat and generally barren portions of arid basins of usually internal drainage that periodically flood and accumulate sediment. Other terms that have been used are: salar (Chile and Spanish speaking lands); sebkha (Arabia, North Africa); ga (Jordan); pans (Southern Africa); takyr (USSR) and kavir (Iran) (Neal, 1975). For the purpose of this discussion the term "playa" will be used.

It has been estimated that there are about 50 000 playas on earth, the vast majority being small having an area of a few square kilometres or less. About 1 000 have areas greater than 100 km^2 (Neal, 1975). Playas may form either under oxidising or reducing conditions.

3.2.1 Classification of playas

Three main types of playas which may contain uranium in some localities have been recognised. Two of the types can be subdivided further into reducing and oxidising varieties. The classification is shown in Table III.

TABLE III : CLASSIFICATION OF URANIFEROUS LACUSTRINE/PLAYA DEPOSITS



Type 1 : Circular topographically controlled playas with fairly steep sides having floors well below the regional elevation

Type 2 : Elongated playas coinciding with palaeo- or choked-drainage channels in which the conditions can be either oxidising or reducing

Type 3 : Floor playas are large and irregular in size and are usually not significantly depressed below the surrounding country. They are related to Type 2 as they form part of a modern drainage superimposed on an older one.

The playa types referred to above are all located in desert environments having no permanent water. Playa sediments are mostly clay- and silt-rich and have been cemented by calcite, gypsum and salt with associated hypersaline water.

An interesting variation is the occurrence of highly reducing conditions in certain playas having marsh and bog sediments, which could conveniently be referred to as cienagas. Such a deposit has been reported by Levin (1978) but others are known to occur elsewhere, and to date at least one has been found to contain ore-grade material. Typically the sediments are composed of organic-rich diatomaceous earth underlain by peaty material. Uraninite and certain oxidised minerals have been found which frequently have a high degree of disequilibrium. As far as is known no uraniferous deposits of a similar nature found elsewhere have been described in the literature.

3.3 Pedogenic

Soil development in desert environments is usually thin. It may con= stitute either *in situ* weathered cover over basement rock or material that has been transported and subsequently transformed into soil.

The assemblage of terms within the "crete" vocabulary such as cal= crete, gypcrete, dolocrete, etc. are all defined as being of pedogenic origin. These cretes have formed *in situ* within or overlying various host materials such as weathered rock, fluviatile (or alluvial) and aeolian sediment.

Uranium has been found to occur in these deposits but at current prices none are considered viable. Carlisle (1980) has discussed some of their features.

Based on the origin of the host material, a classification of pedogenic uranium deposits can be made in the following way as shown in Table IV.

TABLE IV : CLASSIFICATION OF PEDOGENIC URANIUM DEPOSITS

Pedogenic Uranium Deposits

- Authigenic
- Allogenic

Authigenic pedogenic uranium deposits occur in a weathered or decom= posed zone over underlying basement rocks.

This decomposed material is entirely of *in situ* origin and may have been cemented by calcite and gypsum with associated carnotite. Allogenic pedogenic uranium deposits occur in transported host material of fluviatile or aeolian origin.

The terms calcrete and gypcrete uranium deposits are considered appli= cable to these rock types and for lack of a better term are referred to as duricrustal deposits.

4. CONCLUSIONS AND RECOMMENDATIONS

It is concluded that in order to obtain a measure of clarity in the nomenclature the terms calcrete, gypcrete and dolocrete should be dropped when referring to valley-fill and lacustrine/playa deposits. This will have the effect of placing these deposits in categories of their own and not confusing the issue with the over-print of pedogenic calcrete or duricrustal deposits which may or may not be present. Hope= fully, will also eliminate the tendency of referring to a sediment which may contain as little as 5 % or 10 % $CaCO_3$ as a calcrete and thereby making it easier for workers outside Southern Africa and Australia to classify any discoveries they may make of similar deposits in the future.

It is also abundantly clear that at the time of formation of the valley-fill and allied deposits, the climate must in fact have been wetter than it is now. The present-day dry climate has militated against flushing out the carnotite and the preservation of these deposits is therefore entirely due to the current climatic conditions. The significance of these factors should therefore be borne in mind when selecting poten= tial areas suitable for the preservation of uraniferous valley-fill deposits.

Consideration should also be given to the delineation of areas where valley-fill deposits in granitic terrains could have been preserved by younger volcanism. In this context the Neogene Tertiary deposits of Japan (Hayashi, 1970) and those in British Columbia, Canada

(Levinson, pers. comm.), consisting essentially of fluviatile sand=stone, conglomerate and tuffaceous material occurring in channels, and having been preserved by overlying volcanic debris and lava flows, could be regarded as valley-fill deposits. In spite of the fact that these deposits contain some "black ores", it is felt that the proposed valley-fill model could be applied to the Japanese and Canadian deposits and that the location of this type of deposit has been given insufficient attention.

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