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GOLD MORPHOLOGY AND COMPOSITION AT PANGLO, EASTERN GOLDFIELDS, WESTERN AUSTRALIA

K.M. Scott and J.J. Davis

CRC LEME OPEN FILE REPORT 20

September 1998

(CSIRO Division of Exploration Geoscience Report 110R, 1990.
Second impression 1998)

CRC LEME is an unincorporated joint venture between The Australian National University, University of Canberra, Australian Geological Survey Organisation and CSIRO Exploration and Mining, established and supported under the Australian Government's Cooperative Research Centres Program.

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Headquarters: CRC LEME c/o CSIRO Exploration and Mining, Private Bag, PO Wembley, Western Australia, 6014

RESEARCH ARISING FROM CSIRO/AMIRA REGOLITH GEOCHEMISTRY PROJECTS 1987-1993

In 1987, CSIRO commenced a series of multi-client research projects in regolith geology and geochemistry which were sponsored by companies in the Australian mining industry, through the Australian Mineral Industries Research Association Limited (AMIRA). The initial research program, "Exploration for concealed gold deposits, Yilgarn Block, Western Australia" (1987-1993) had the aim of developing improved geological, geochemical and geophysical methods for mineral exploration that would facilitate the location of blind, buried or deeply weathered gold deposits. The program included the following projects:

P240: Laterite geochemistry for detecting concealed mineral deposits (1987-1991). Leader: Dr R.E. Smith.
Its scope was development of methods for sampling and interpretation of multi-element laterite geochemistry data and application of multi-element techniques to gold and polymetallic mineral exploration in weathered terrain. The project emphasised viewing laterite geochemical dispersion patterns in their regolith-landform context at local and district scales. It was supported by 30 companies.

P241: Gold and associated elements in the regolith - dispersion processes and implications for exploration (1987-1991). Leader: Dr C.R.M. Butt.
The project investigated the distribution of ore and indicator elements in the regolith. It included studies of the mineralogical and geochemical characteristics of weathered ore deposits and wall rocks, and the chemical controls on element dispersion and concentration during regolith evolution. This was to increase the effectiveness of geochemical exploration in weathered terrain through improved understanding of weathering processes. It was supported by 26 companies.

These projects represented "an opportunity for the mineral industry to participate in a multi-disciplinary program of geoscience research aimed at developing new geological, geochemical and geophysical methods for exploration in deeply weathered Archaean terrains". This initiative recognised the unique opportunities, created by exploration and open-cut mining, to conduct detailed studies of the weathered zone, with particular emphasis on the near-surface expression of gold mineralisation. The skills of existing and specially recruited research staff from the Floreat Park and North Ryde laboratories (of the then Divisions of Minerals and Geochemistry, and Mineral Physics and Mineralogy, subsequently Exploration Geoscience and later Exploration and Mining) were integrated to form a task force with expertise in geology, mineralogy, geochemistry and geophysics. Several staff participated in more than one project. Following completion of the original projects, two continuation projects were developed.

P240A: Geochemical exploration in complex lateritic environments of the Yilgarn Craton, Western Australia (1991-1993). Leaders: Drs R.E. Smith and R.R. Anand.
The approach of viewing geochemical dispersion within a well-controlled and well-understood regolith-landform and bedrock framework at detailed and district scales continued. In this extension, focus was particularly on areas of transported cover and on more complex lateritic environments typified by the Kalgoorlie regional study. This was supported by 17 companies.

P241A: Gold and associated elements in the regolith - dispersion processes and implications for exploration. Leader: Dr. C.R.M. Butt.
The significance of gold mobilisation under present-day conditions, particularly the important relationship with pedogenic carbonate, was investigated further. In addition, attention was focussed on the recognition of primary lithologies from their weathered equivalents. This project was supported by 14 companies.

Although the confidentiality periods of the research reports have expired, the last in December 1994, they have not been made public until now. Publishing the reports through the CRC LEME Report Series is seen as an appropriate means of doing this. By making available the results of the research and the authors' interpretations, it is hoped that the reports will provide source data for future research and be useful for teaching. CRC LEME acknowledges the Australian Mineral Industries Research Association and CSIRO Division of Exploration and Mining for authorisation to publish these reports. It is intended that publication of the reports will be a substantial additional factor in transferring technology to aid the Australian Mineral Industry.

This report (CRC LEME Open File Report 20) is a Second impression (second printing) of CSIRO, Division of Exploration Geoscience Restricted Report 110R, first issued in 1990, which formed part of the CSIRO/AMIRA Project P241.

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PREFACE

The CSIRO-AMIRA project "Exploration for Concealed Gold Deposits, Yilgarn Block, Western Australia" has as its overall aim the development of improved geological, geochemical and geophysical methods for mineral exploration that will facilitate the location of blind, concealed or deeply weathered gold deposits.

This Report presents results of research conducted as part of Module 2 of this project (AMIRA Project 241). "Gold and Associated Elements in the Regolith - Dispersion Processes and Implications for Exploration".

The objectives of this module are:

i. To obtain a better understanding of the nature and genesis of lateritic and supergene gold deposits.

ii. To determine characteristics useful for exploration, especially in areas of transported overburden for: a) further lateritic and supergene deposits, and b) primary mineralization - including that with no expression as appreciable secondary mineralization.

iii. To increase knowledge of the properties and genesis of the regolith.

iv. To provide data applicable for exploration for other commodities in and beneath the regolith.

In particular this report documents the composition and morphology of gold from the supergene ore at Panglo thereby specifically addressing objective (i).

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Fig. 18 Detail of terminated face, showing scratching and pitting (PSRC 275:36-37, BSE image).

SUMMARY

Coarse >80 μm gold from the mineralized horizon in the weathered zone at 30 to 40 m below the surface at Panglo may be xenomorphic or euhedral. Xenomorphic forms are composed of pseudohexagonal platelets which are often severely pitted and may also have ?cryptocrystalline spherules within pits and voids. Euhedral gold occurs as aggregates or as single dodecahedral or elongate crystals. No Ag was detected in any of the grains studied. All the above features are consistent with the gold being supergene, possibly forming during lateritization and being corroded during the subsequent arid period.

1. INTRODUCTION

The broad distribution of economic Au grades at depths of 30 to 40 m below the surface, cutting across lithological boundaries at Panglo, 30 km N of Kalgoorlie, suggests that the Au is supergene. Under the saline conditions prevailing at Panglo such Au would be expected to be of high fineness (cf. Mann, 1984; Webster and Mann, 1984). However the occurrence of Ag within the ore horizon in some intersections (e.g. PSRC 342; Scott, 1989) suggests that some gold grains could contain some Ag, possibly reflecting a primary gold component in the ore.

This report presents results from a combined morphological and compositional study of gold grains to resolve the nature of the gold. As such it complements the work done by Freyssinet and Butt (1988a, b and c) at Reedy, Bardoc and Beasley Creek.

2. SAMPLES

Five samples were taken from 1 m composites of reverse circulation fragments at high grade (≥ 20 g/t) interactions in both mafic and sedimentary host rocks within the deposit. The locations, rock type and grade of the 1 m composite are listed below:

PSRC 312:47-48 m, sedimentary/mafic	43.1 g/t
PSRC 332:41-42 m, sedimentary/mafic	41.3 g/t
PSRC 360:37-38 m, mafic	29.7 g/t
PSRC 254:44-45 m, sedimentary	18.9 g/t
PSRC 275:36-37 m, sedimentary	35.5 g/t

3. METHODS

The samples were concentrated by panning the original reverse circulation fragments by R.W. Howard (Pancontinental Mining Ltd.). The concentrates (~1 g of material) generally consisted of quartz, iron oxides and gold grains. In the North Ryde Laboratories of CSIRO Division of Exploration Geoscience each sample was further concentrated using a vacuum tweezer unit to remove gangue. Gold grains were examined carefully under a binocular microscope with representative types of grains being selected for scanning electron microscopic (SEM) study.

Samples were mounted on an aluminium stud using graphite dag but were not coated. Detailed study was carried out using a Cambridge Stereoscan 240 SEM operated at 30 kV. Both back scattered electron (BSE) images and secondary electron (SE) images are presented. Qualitative analytical information was determined using the Tracor Northern energy-dispersive X-ray fluorescence system (EDS) attached to the SEM.

4. RESULTS

4.1 PSRC 312:47-48 m

Gold grains may vary in size between 80 and 250 µm. They are yellow/red in colour often with dark areas of Fe oxides adhering to them. One grain was seen to have an adhering quartz grain.

Under the SEM the grains are seen to be xenomorphic with either smooth euhedral faces and impressions of surrounding crystals, ?quartz (Fig. 1), or pitted pseudohexagonal platelets and ?cryptocrystalline non-corroded spherules (Figs. 2-6). No Ag was observed within the gold grains by EDS.

4.2 PSRC 332: 41-42 m

Gold grains are 80 to 500 µm across. They are yellow in colour and have no adhering Fe oxides or silicates. They show no pitting or pseudohexagonal platelets. No Ag was observed by EDS within these grains.

4.3 PSRC 360: 37-38 m

The gold grains are yellow and bright and up to 250 µm across. Euhedral crystal faces are obvious in some grains with Fe oxides present in spaces between distinct crystals. Close inspection shows euhedral crystals are composed of pseudohexagonal platelets (Figs. 7-10). Other grains are more xenomorphic being composed of pseudohexagonal platelets and spherules (Fig. 11). Fe oxides present within the cavities in these grains had a colloform texture. Pitting is not obvious.

EDS showed no Ag present within the Au crystals.

4.4 PSRC 254: 44-45 m

Gold grains within this sample ranged from elongate (50 x 300 µm) to more equant and ranging from 100 to 300 µm across. Quartz and colloform Fe oxides are attached to many grains which are generally shiny yellow and pitted (Fig. 12).

EDS showed no Ag within Au crystals.

4.5 PSRC 275: 36-37 m

Both yellow and black gold/Fe oxide composites and bright yellow dodecahedral or elongate crystalline grains occur in this sample. The composite grains are xenomorphic being composed of pseudohexagonal platelets which are badly corroded, often with finely intergrown Fe oxides and silicates within the corrosion pits (Figs. 13 and 14). Dodecahedral grains are approximately 100 µm across and have well developed faces embedded with quartz and Fe oxide. Pitting also occurs on the crystal faces (Figs. 15 and 16). Of the elongate grains, one is 50 x 150 µm in size and has well defined crystal faces which are severely scratched and pitted (Figs. 17 and 18). Other elongate grains are tapered at one end.

No Ag was found in any of these gold grains by EDS.

5. DISCUSSION AND CONCLUSIONS

Although the gold is generally xenomorphic, SEM studies show that it is comprised of pseudohexagonal platelets. These platelets are only a few µm thick but ≥ 50 µm across (Fig. 10) and may be strongly pitted (Fig. 4). These features are all consistent with a supergene origin for the gold during weathering (i.e. lateritisation and subsequent aridity which gave rise to saline conditions), with the pitting probably resulting from the saline conditions. If this interpretation is correct the late stage ?cryptocrystalline spherules present in voids in some of these samples may represent gold precipitated under saline conditions. The lack of corrosion in some grains may reflect protection afforded by Fe oxide or other coatings on the gold. Alternatively the lack of corrosion could indicate the occurrence of several periods of gold formation, with some formed before, and some after the corrosion event, as suggested at the nearby Bardoc Mine by Freyssinet and Butt (1988b).

At present the only high grade intervals found during limited deeper diamond drilling at Panglo occur in clay-rich fracture (i.e. ?weathered) zones (R.W. Howard, pers. comm., 1989). Thus no undisputed primary gold from the Panglo area is available for study. However, because primary gold at Paddington and Bardoc (5 km and 25 km N of Panglo respectively) contains about 10% Ag (Robertson et al., 1988; Freyssinet and Butt, 1988b), primary gold from the Panglo area would also be expected to contain Ag. If so, the absence of Ag in the gold grains examined in this study would also be consistent with a secondary (supergene) origin for the economic gold mineralization at Panglo.

Although the method of sampling has strongly biassed the size distribution of the grains, so that no grains smaller than 80 μm were studied, there is no reason to suspect that these results are not representative of the supergene gold at Panglo.

6. ACKNOWLEDGEMENTS

Bob Howard (Pancontinental Mining Ltd., Kalgoorlie) is thanked for supplying the samples. John Corcoran (CSIRO, Division of Coal Technology) is thanked for advice in the use of the SEM and its attached EDS.

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Fig. 1 Xenomorphic grain with smooth euhedral faces and impressions from surrounding ?quartz crystals. Note fine banding (platelets in section) at top of grain. (PSRC 312:47-48, BSE image).

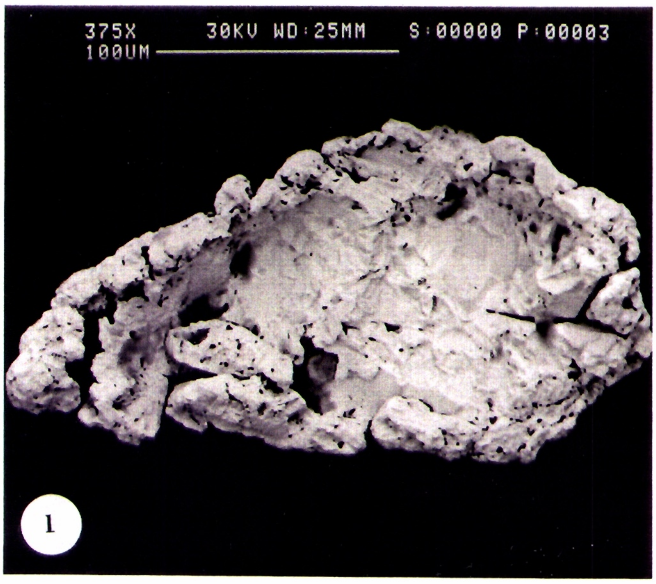
Fig. 2 Pitted xenomorphic grain showing Fe oxide coatings (grey areas) and faint outline of platelets in vertical section (PSRC 312:47-48. BSE image).

Fig. 3 Same grain as in Fig. 2 with platelets more obvious (SE image).

Fig. 4 Pitted pseudohexagonal platelets seen in horizontal section (PSRC 312:47-48, BSE image).

Fig. 5 Platelets seen in vertical section with 5 μm spherules also present (PSRC 312:47-48, BSE image).

Fig. 6 ?Cryptocrystalline spherules forming in voids between pitted platelets (PSRC 312:47-48, BSE image).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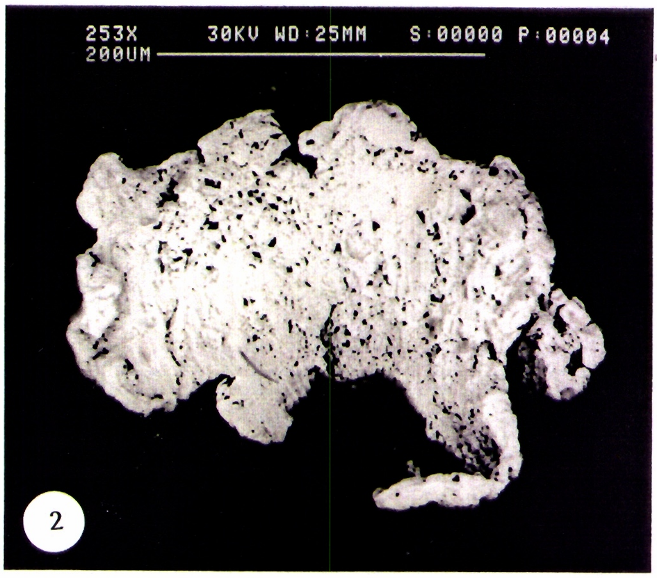
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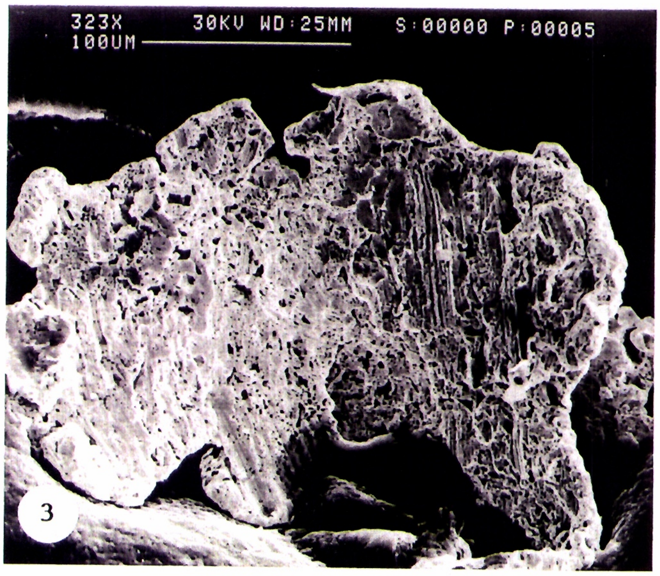
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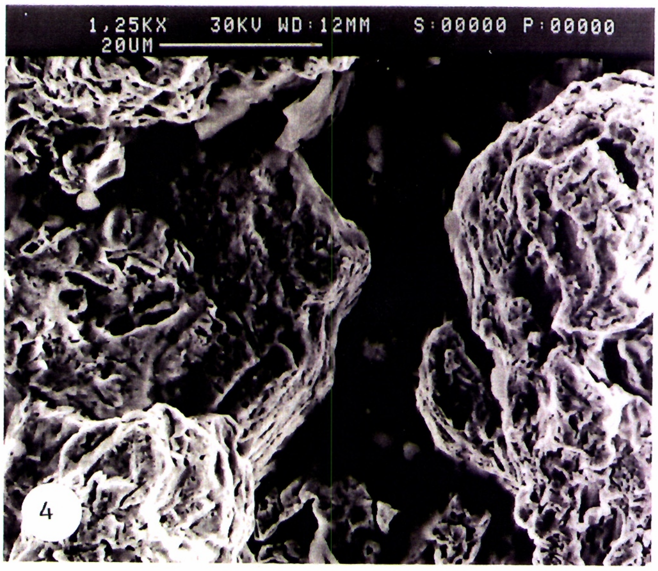
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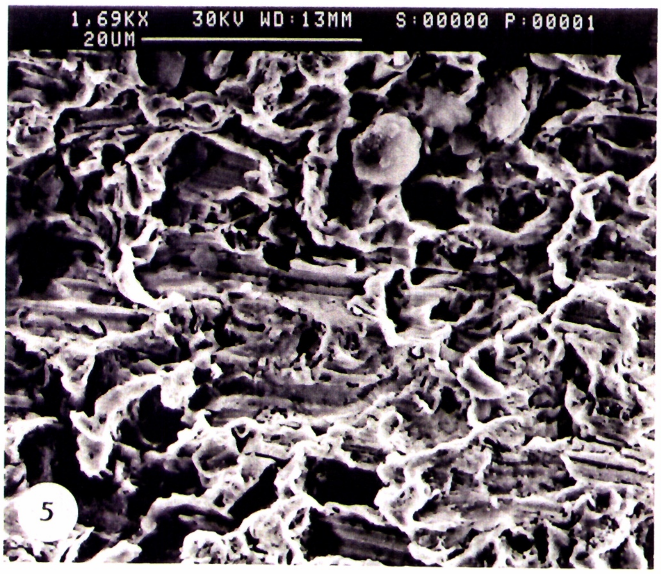
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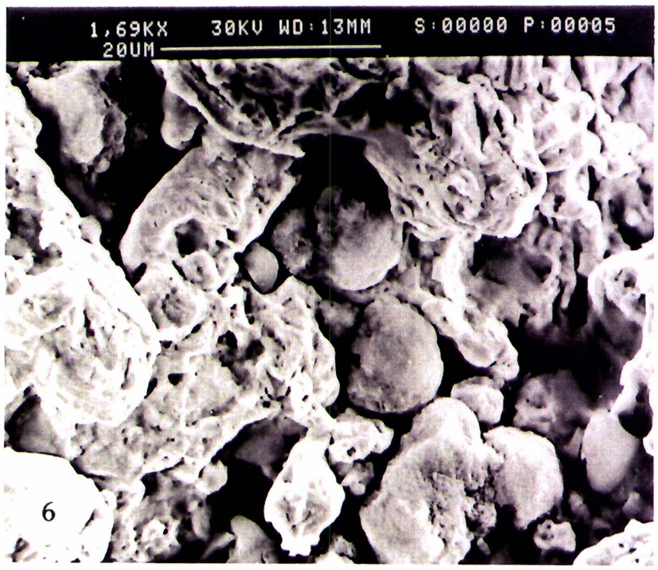
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Fig. 7 Aggregate of euhedral crystals with Fe oxides in depressed areas between crystals (PSRC 360:37-38, BSE image).

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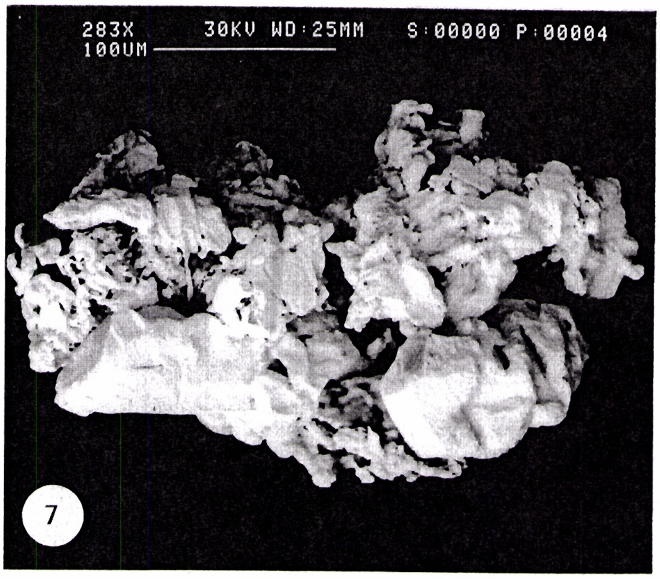
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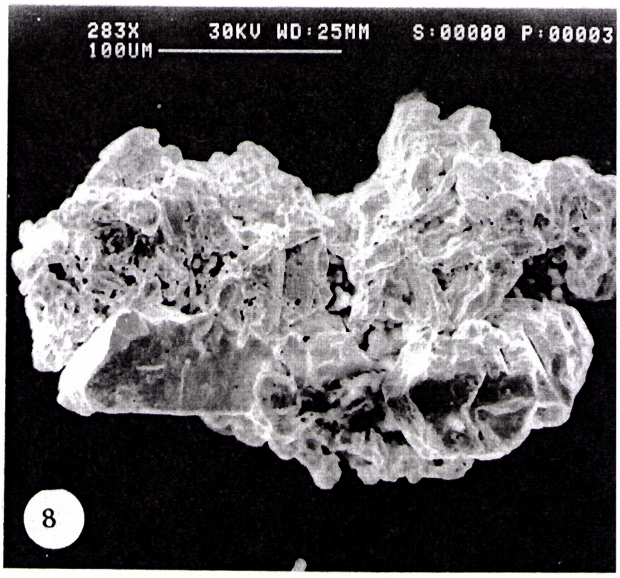
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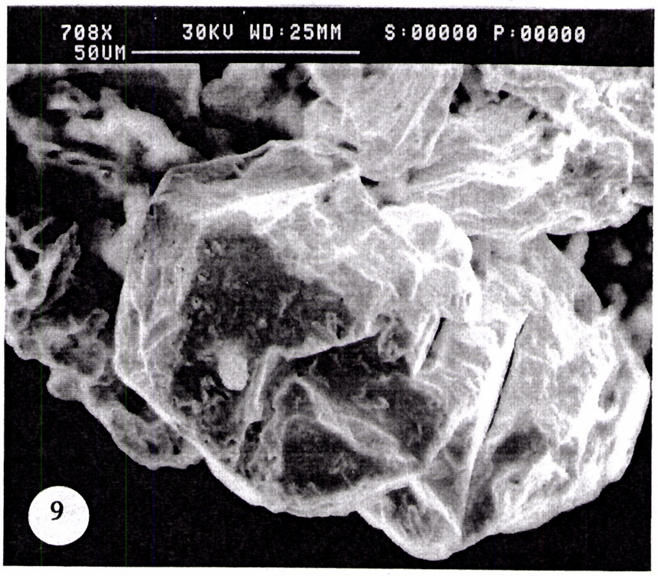
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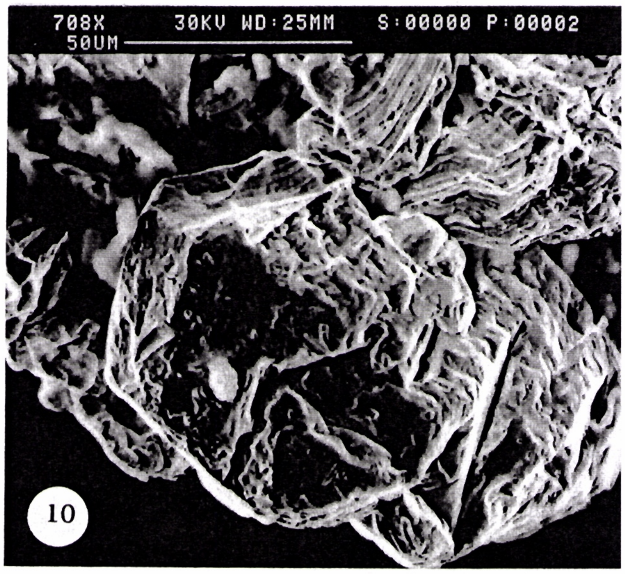
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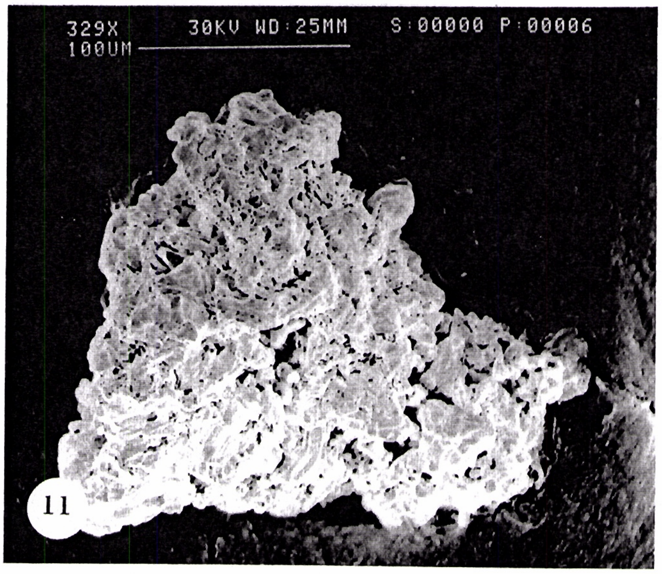
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Fig. 13 Xenomorphic grain composed of black Fe oxides and euhedral gold composed of pseudohexagonal platelets (PSRC 275:36-37, BSE image).

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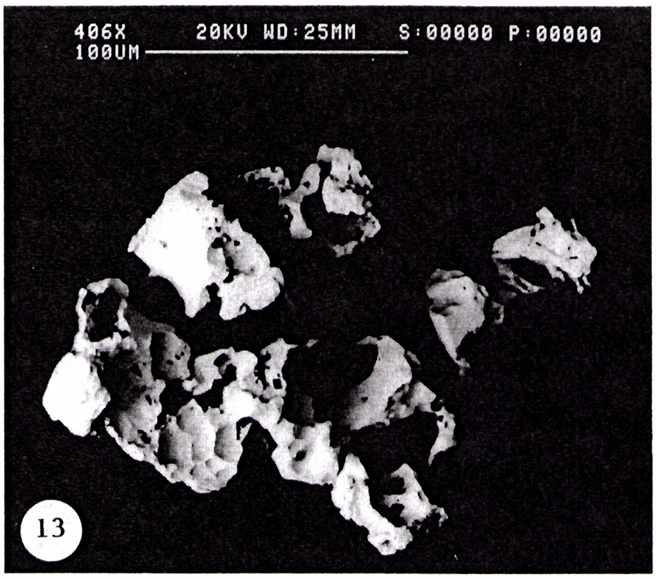
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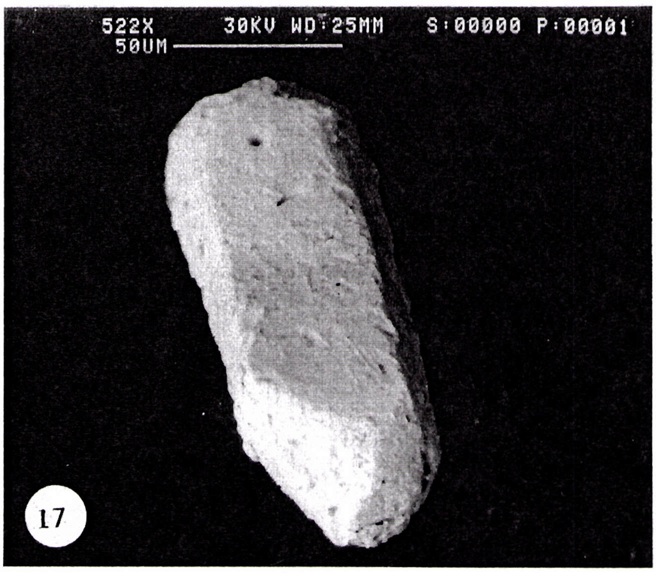
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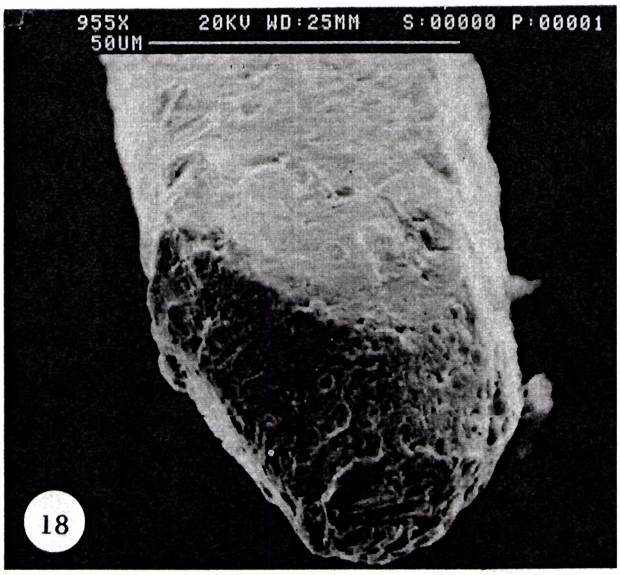
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