Plate 6.12

a. Outcrop of massive facies O sandstones, passing up to bedded facies P sandstones, and overlain by facies M interbedded mudstone-sandstone. MS25.

b. Outcrop of facies O sandstones. MS25.

c. Facies O sandstones. Note normal grading and parallel layering in the lower bed. MS25.

d. Detail of scour in facies O sandstones. Mudstone fragments fill the scour. MS25.

e. Detail of scour in facies O sandstones. Truncation of thin bedded mudstone-sandstone sequence. MS25.

f. Outcrop of facies P sandstones with facies M interbedded mudstone-sandstone sequences. MS25.

g. Channelling in facies P sandstones. MS25.

h. Channel filled with facies P sandstones and thin mudstone layers. Scattered pebbles and mud clasts occur in the base of the channel. MS25.

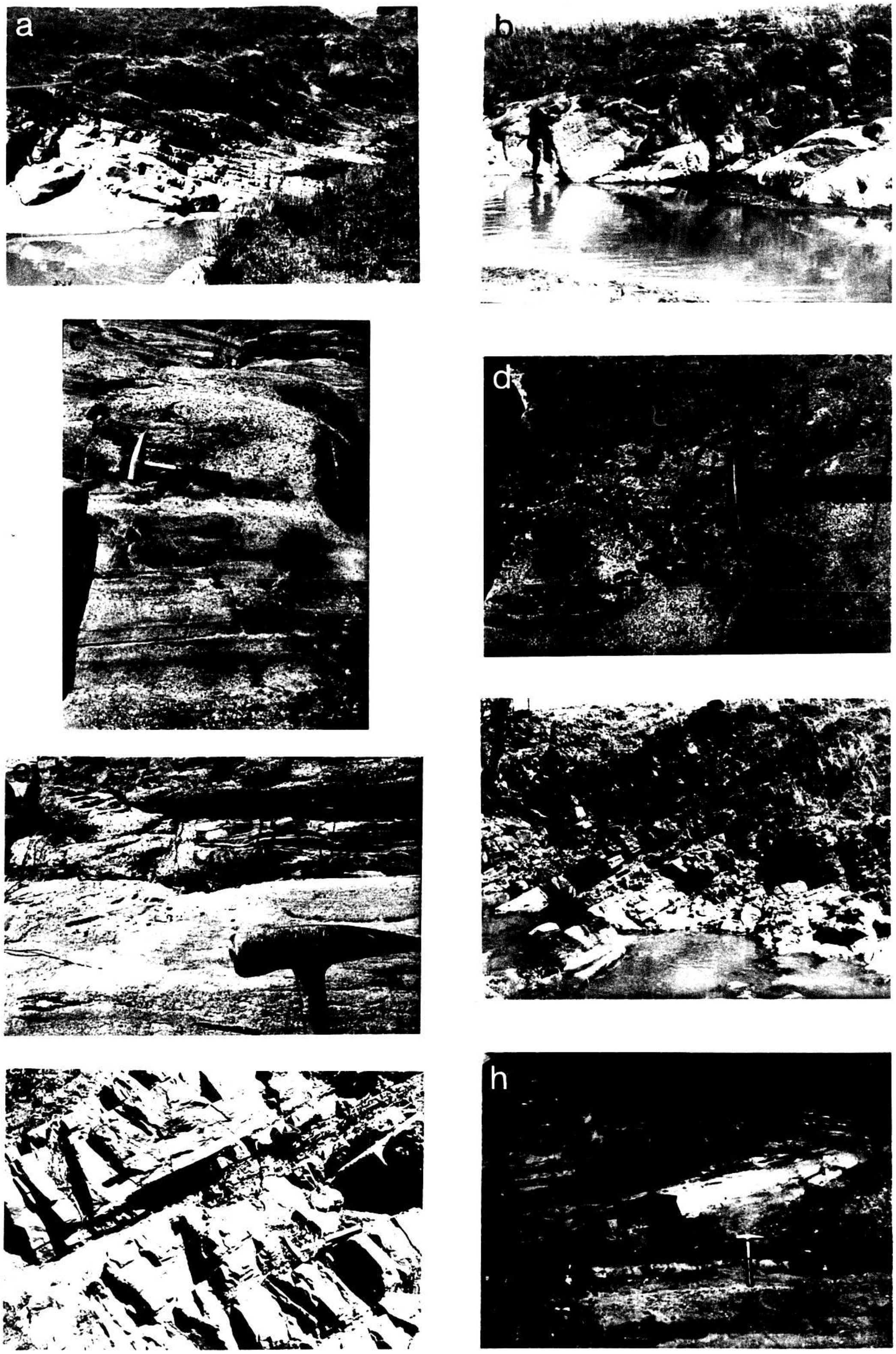

Plate 6.12

6. Facies P Sandstones

This facies consists of thin to thick bedded medium to very coarse sandstones. They are often normally graded, may possess finer basal layers (Plate 6.13e), and are usually parallel laminated. This parallel lamination commonly occurs throughout the entire bed, but in some instances is best developed in the upper half of the bed (Plate 6.13a,b,d,e,f). Cross stratification is occasionally seen (Plate 6.13c) while small scale trough cross stratification occurs in the upper intervals of many sandstones, overlying the parallel lamination (Plate 6.13b). The basal contacts of the sandstones are abrupt, often erosional, and with load casts frequently present (Plate 6.13d,e,f,g). Scours present, in some instances, possess thin mudstone drapes. The upper contacts of the sandstones are also abrupt, and not gradational to overlying mudstones which may be present (Plate 6.13d,e,f,g). They are frequently scoured by overlying sandstones (Plate 6.13d,f). Mudstone clasts are often present, in some instances in sufficient concentration to warrant the bed being termed a mudclast breccia.

Mudstone occurs as a minor lithology with the sandstones of this facies. It occurs as thin beds to laminae with interbedded thin sandstones in intervals up to 50 cm thick separating the thicker sandstones (Plate 6.13h). These intervals become, in general, thicker and with more mudstone relative to sandstone towards the overlying mudstone facies. In the case of the lower sandstone facies P sequence, the sandstone beds become correspondingly thinner.

Sandstones of sandstone facies P occur at three intervals within this section (Fig. 6.3), in two instances overlying sandstone facies O and overlain by the mudstone-sandstone facies M.

Sandstone facies O and P are essentially end members of a gradational series, with sandstones of facies O grading to those of facies P by a general decrease in coarseness and bed thickness, and an increase in the development of internal structures, i.e., better developed parallel lamination and the presence of cross stratification.

Plate 6.13

a. Facies P sandstone, note inverse grading, normal grading, parallel lamination, basal loadcast. MS25.

b. Facies P sandstone, trough cross stratification overlying parallel lamination. MS25.

c. Facies P sandstones, cross stratification. MS25.

d. Facies P sandstones, note basal scouring, parallel lamination, with muddy laminae, normal grading, loadcasts and flame structures in the uppermost bed. MS25.

e. Facies P sandstones, note loadcasts with some scouring, inverse grading, normal grading, parallel lamination, mudstone fragments, basal scouring in uppermost bed. MS25.

f. Facies P sandstones, note scoured and non-scoured basal contacts, parallel lamination, normal grading. MS25.

g. Facies P sandstones, note normal grading, parallel lamination, mudstone fragments and basal scouring. MS25.

h. Thin bedded mudstones and sandstones interbedded with facies P sandstones. Note the very thin bedding and irregular thickness of the sandstones. MS25.

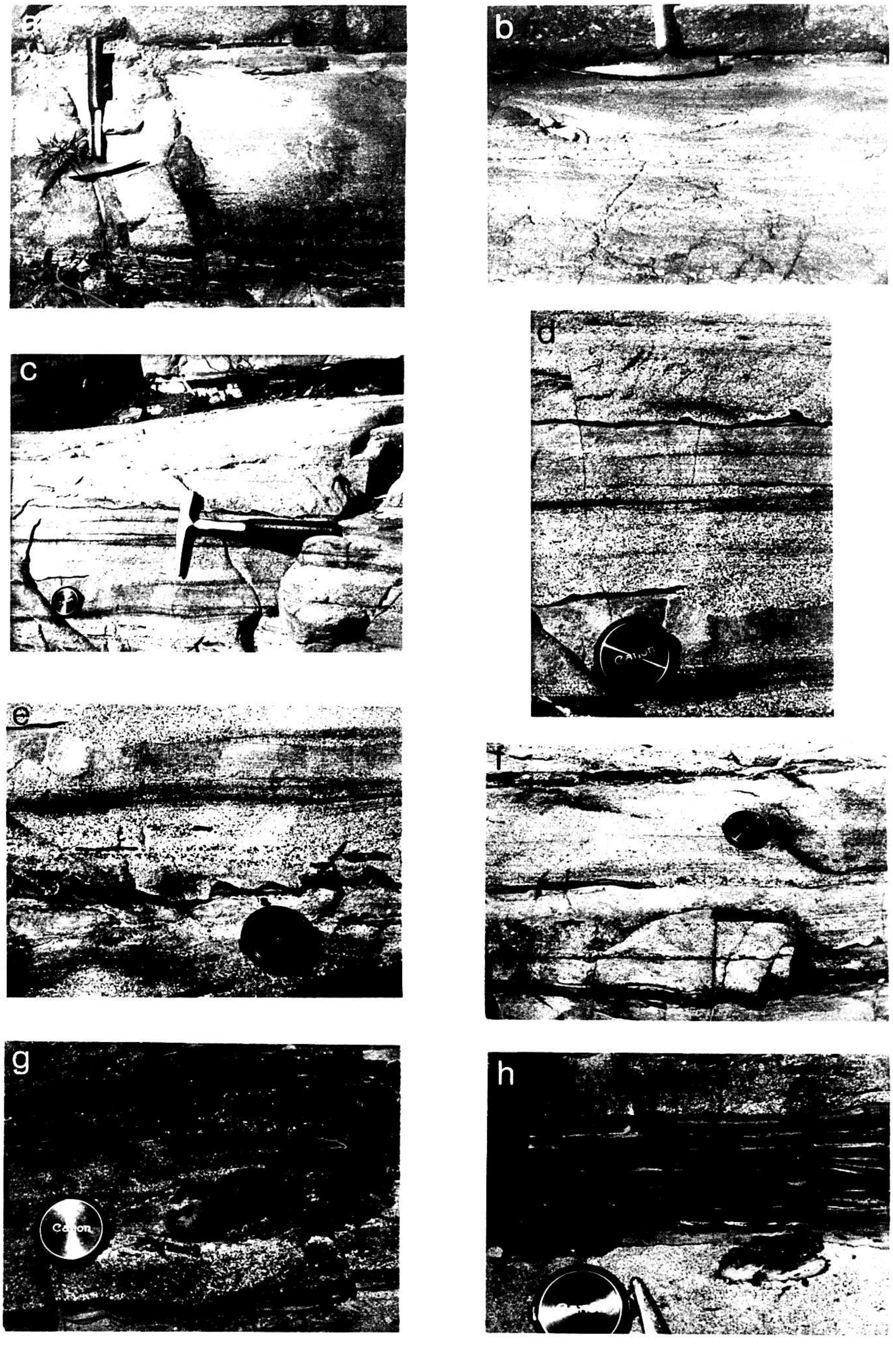

Plate 6.13

E. SUBDIVISIONS OF THE MARINE DOMAIN OF SEDIMENTATION

1. Facies Associations:

The common marine facies tend to occur as three distinct associations. These are:

Facies Association A. Characterised by the massive and graded coarse clast supported conglomerate and massive sandstone facies.

Facies Association B. Characterised by the graded pebble conglomerate and graded pebbly sandstone facies.

Facies Association C. Characterised by the graded sandstone facies, the facies K sandstones, and the interbedded mudstone-sandstone facies M.

Other facies are present within these three facies associations but are of minor occurrence.

2. Subdivisions of the Marine Domain:

From the vertical and lateral relationships of these three facies associations three subdivisions of the marine domain of sedimentation may be recognised*. These subdivisions are shown diagramatically in Fig. 6.4.

Subdivision I: consists of Facies Association A with minor matrix supported coarse conglomerate and interbedded mudstone-sandstone facies M.

Subdivision II: consists of Facies Associations A and B, less commonly C, with minor matrix supported coarse conglomerate and diamictite facies.

Subdivision III: consists of Facies Association C, with minor clast supported and matrix supported coarse conglomerate facies, graded pebble conglomerate and graded pebbly sandstone facies, and massive mudstone facies.

3. Lateral Relationships of the Subdivisions:

Fig. 6.4 shows the distribution of the three subdivisions. It can be seen that subdivision II occupies the greatest area. Subdivision I, of

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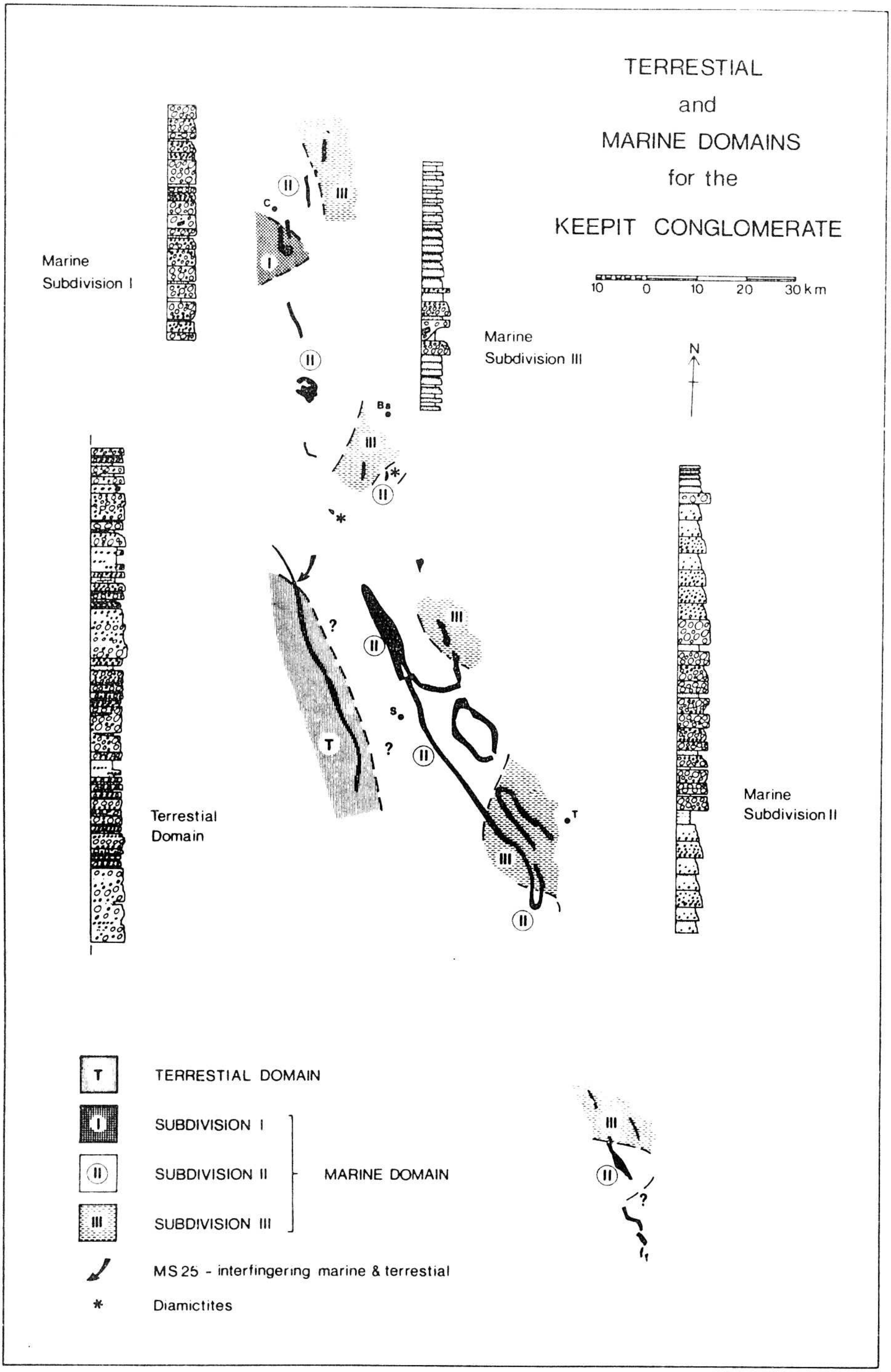
* MS25 does not fit into any one of the three subdivisions. The relationship of this section to the subdivisions, and its significance, is discussed later (p.208).

Fig. 6.4. Terrestial and Marine Domains for the Keepit Conglomerate.

The figure shows the distribution of the Keepit Conglomerate, and the occurrence and areal extent of both a terrestial and a marine domain of sedimentation. The marine domain is subdivided into three subdivisions, I, II and III. Boundaries between the domains and subdivisions are approximate.?? between the terrestial domain and marine domain subdivision II in the Lake Keepit - Somerton area relates to the possible presence of subdivision I lithologies beneath the Carboniferous of the Belvue Basin.

Also shown are schematic columnar sections, compiled from complete and incomplete measured stratigraphic sections, for the terrestial domain and the three subdivisions of the marine domain. The location of MS25, in which marine and terrestial sediments interfinger, and the few localities of diamictites (Flint *et al.* 1960a,b) are also indicated.



TERRESTIAL
and
MARINE DOMAINS
for the
KEEPIT CONGLOMERATE
10 0 10 20 30 km
N
Marine
Subdivision I
Marine
Subdivision III
Terrestial
Domain
Marine
Subdivision II
C
Ba
S
T
?
TERRESTIAL DOMAIN
SUBDIVISION I
SUBDIVISION II
SUBDIVISION III
MARINE DOMAIN
MS 25 - interfingering marine & terrestial
Diamictites

restricted extent, occurs to the north and west of subdivision II, while subdivision III occurs east of, and in the Timor area, north of, subdivision II. MS14 provides an anomaly, as an area of subdivision II occurring east of an area of subdivision III (MS13).

This present areal relationship of the three subdivisions must be considered with the realisation that faulting has modified the original distribution (e.g., MS11 and MS12 have been thrust eastwards for at least one mile by the Campo Santo Thrust (White, 1966, p.279)). However, the occurrence of a subdivision III east of a subdivision II east of a subdivision I appears to be real, despite subsequent fault displacement. It is probable that subdivision I occurs beneath the Belvue Basin (Fig. 2.1), between the Terrestial Domain and subdivision II of the Marine Domain.

4. Subdivision I:

This subdivision is of restricted occurrence only occurring south of Caroda (Fig. 2.1), and is best exemplified by MS7, MS8 and MS9. It is characterised by the presence of facies association A. Complete sections indicate the clast supported coarse conglomerate facies to be dominant with subordinate massive sandstone facies. The matrix supported coarse conglomerate facies and interbedded mudstone-sandstone facies M are present in some instances (MS8, MS7 and MS9 respectively).

The Keepit Conglomerate within subdivision I ranges in thickness from 23.75 metres to in excess of 83.5 metres. It disconformably overlies the Eungai Mudstone with gentle erosional contacts (MS7, MS9, Plate 2.1). The Keepit Conglomerate is in turn overlain abruptly and conformably (MS7) by the Mandowa Mudstone.

5. Subdivision II:

This subdivision is the most extensive of the three recognised (Fig. 6.4). It is best developed in the Somerton area and is also prominent in the Timor area. Representative sections include MS4, MS20, MS21, MS39.

Subdivision II is characterised by the presence of facies association A with facies association B. Less commonly, facies association C is present. The matrix supported coarse conglomerate facies (MS21), graded pebbly sandstone facies (MS38), graded sandstone facies (MS38) and mudstone dominant interbedded mudstone-sandstone facies M (MS14) are very minor occurrences within facies association A of this subdivision. The graded sandstone facies, facies K sandstones, and the interbedded mudstone-sandstone facies M occur associated with Facies assocation B.

Complete sections for this subdivision are not exposed. In general, facies association A appears to be subequal to or more plentiful than B. This may, however, reflect outcrop control. Facies association B occurs either underlying (e.g., MS17, MS20, MS38) or overlying (e.g., MS16, MS21, MS39) facies association A. In both instances the contact, when exposed, is abrupt. In the case of MS20 and MS38 thick intervals of interbedded mudstone-sandstone facies M separates B from the overlying A.

Included within subdivision II are those sections where facies association A occurs with both facies associations B and C (MS39, MS40), or with only C (MS4, MS14, MS19). In MS40 facies association A is overlain by facies association B, in turn overlain by C which passes gradationally to the Mandowa Mudstone. MS39 and MS40 thus represent an overall fining up sequence. The contact between facies associations A and C, where exposed, is abrupt (MS4, MS14). Facies association C usually occurs overlying A, but in one instance (MS14) occurs beneath.

Also included within subdivision II are a number of incomplete sections and localities of facies association B (Sections MS11, MS18, MS22, MS23, MS24, loc.G). In the case of Section MS11 and probably also loc.B (complicated by faulting) facies association B passes up to facies association C characterised by dominant graded sandstone facies.

Incomplete exposure and structural controls prevent positive determination of the presence or absence of facies association A. Two possibilities exist:

1. Facies association A is present but does not outcrop. The close geographic association of many of these sections with others containing thick sequences of facies association A supports this.

2. Facies association A is absent. This could well apply for some instances well south of the Somerton area (e.g., loc.G), but the quality of outcrop is so poor that no conclusion may be drawn.

The actual absence of facies association A within subdivision II would sugge the existence of marked lateral lithological variation within this subdivision. The existence of some lateral variation within the subdivision is indicated by the facies types immediately overlying the Baldwin Formation in the Somerton area. In MS17, for example, the graded pebbly sandstone facies immediately overlies the Baldwin Formation, while at locality D the basal Keepit Conglomerate consists of matrix supported coarse conglomerates. A similar situation exists in the area of MS14, with both interbedded mudstone-sandstone facies M (sandstone dominant) and the clast supported coarse conglomerate facies overlying the Eungai Mudstone. Further indication of lateral facies variation is given by the varying degrees of development of facies association B beneath A. However, in all of these instances both facies associations A and B are present.

It is considered that in those isolated sections of incomplete exposure closely associated in distance to sections typical of subdivision II (i.e., MS18, MS22, MS23, MS24 and loc.B) facies association A is probably present but does not outcrop. The occurrence of conglomerate in localities to the north, east and south (loc.'s A,E,F; Fig. 2.2) of these sections is considered to support this conclusion. For those localities well south of Somerton (loc.G, e.g.) no conclusion can be made due to the very poor outcrop. Conglomerate does occur in two nearby localities of the Keepit Conglomerate (loc.'s H,I) but cannot be traced more than 4 kilometres.

The Keepit Conglomerate in subdivision II ranges in thickness up to 312 metres (MS38). Exposed basal contacts indicate the Keepit Conglomerate to abruptly overlie the Eungai Mudstone with apparent conformity (MS14), or the Baldwin Formation either conformably (north of MS18) or disconformably (MS17, loc.D) (Plate 2.1). The upper contact appears abrupt and conformable with the Mandowa Mudstone (MS4, MS18). In MS40 the upper contact is gradational over some 20 to 30 metres.

6. Subdivision III:

This subdivision is not as extensive in terms of present day exposure as subdivision II. It is best developed in the Caroda-Bingara area. Representative sections include MS1, MS3, MS5, MS6 and MS13. It is characterised by the occurrence of facies association C, with subordinate development of the clast supported coarse conglomerate facies E (MS5, MS13), the matrix supported coarse conglomerate facies F (MS2, MS3, MS5), the graded pebble conglomerate facies H (MS13), the graded pebbly sandstone facies I (MS13) and the massive mudstone facies N (MS3). Facies association C occurs above and below these subordinate facies occurrences. This represents, for sections containing facies E,F,H or I, upward coarsening followed by upward fining.

In two sections (MS3 and MS5), erosional channels are present. They are discussed in more detail below:

The Keepit Conglomerate within this subdivision ranges in thickness from 16.5 metres (MS6) to 110 metres (MS13). It conformably overlies the Eungai Mudstone with a gradational contact over an interval of some 5 metres, (MS1, MS2; Plate 2.1) and is similarly overlain by the Mandowa Mudstone (MS1, MS2, MS13) with a gradational interval of some 25 (MS1) to 35 (MS13) metres.

MS33, MS35, MS36 in the Timor area are included in this subdivision. These sections (thickness range 16 to 60 metres) contain plentiful inter-bedded mudstone-sandstone facies M with facies J graded sandstone and facies K sandstones. Pebble conglomerates (facies E1, E2 aspect) some of which are graded, may also be present. In some instances the Keepit Conglomerate consists apparently solely of pebble conglomerate (facies E1) in the order of 4.5 (MS34) to 8.5 (MS37) metres thick within mudstone-fine sandstone sequences (as facies M). These sequences all appear to be conformable with the underlying and overlying mudstone rich sequences. Rather than establish a fourth subdivision, and in view of the presence in some of these sections of facies association C type lithologies, these sections are included within subdivision III.

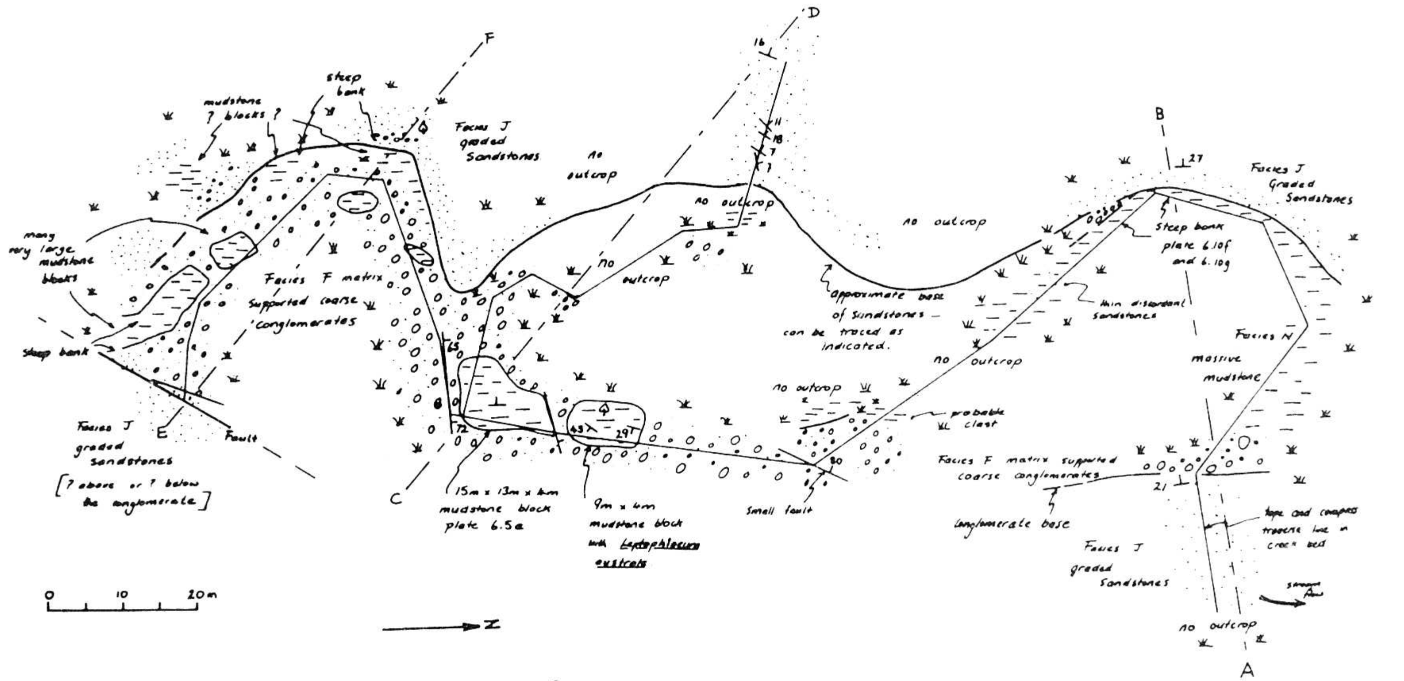
7. Erosional Channels within Subdivision III:

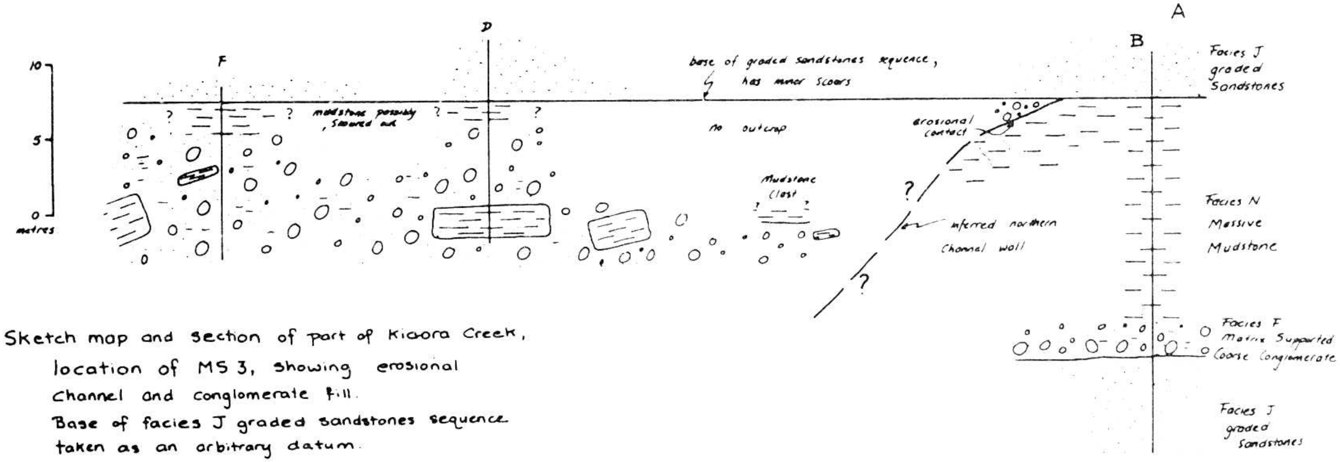
Two prominent erosional channels were observed within the Keepit Conglomerate in subdivision III (MS3 and MS5).

In MS3 a very thick massive pebble-cobble matrix supported conglom-erate (facies F) occupies a channel, in excess of 10m deep, incised into and through mudstone of facies N (Fig. 6.5). Within the conglomerate occurs a number of angular essentially undeformed tabular mudstone blocks of variable orientation. Some of these blocks reach considerable sizes,

Fig. 6.5.

Sketch map and section of part of Kiaora Creek, location of MS3, showing the erosional channel and facies F matrix supported conglomerate channel fill. The base of the facies J graded sandstone sequence is taken as an arbitrary datum for the section. This is not meant to imply a regular, horizontal base for this sequence, as scouring to a depth of 1 metre may be observed. The map and section are based on a tape and compass traverse. Much of the area in the creek bed is sand covered, and on the surrounding low slopes grass covered.





Sketch map and section of part of Kiaora Creek, location of MS 3, showing erosional channel and conglomerate fill.
Base of facies J graded sandstones sequence taken as an arbitrary datum.

e.g., 15 x 13 x 4 metres (Plate 6.5e). They are completely surrounded by conglomerate; some clasts occur pressed into the mudstone blocks (Plate 6.5f). The blocks contain fragments of *Leptophloeum australe* and resemble the mudstone into which the channel is cut. Accordingly, they are interpreted as being of intraformational origin. Laminated calcareous clasts up to 95 cm, and similar to the concretions within the mudstone blocks and the mudstone of facies N, also occur within the matrix supported conglomerate. Breakdown of the intraformational mudstone clasts during sedimentation, possibly coupled with erosion of the channel walls, is considered to have been a major source of the mud present within the conglomerate matrix. The "patchiness" of the muddy sandstone is consistent with the mud being of "local" derivation rather than there having been a high original mud content within the conglomerate matrix (p.181).

The occurrence within the channel fill conglomerate of large mudstone blocks, considered derived from the mudstone unit into which the channel is cut, suggests that in this instance both erosion and sedimentation were closely associated in time and space. The orientation of the channel could not be determined.

Near the northern wall of the channel a number of irregular, in places discordant, thin sandstone beds occur within the mudstone. These appear to have resulted from sand being injected into tension fractures resulting from the "calving off" of the large mudstone blocks.

In MS5 a channel is cut to a depth in the order of 4 to 7.5 metres into a sequence of sandstones. The channel fill is a pebble-cobble clast supported conglomerate containing occasional boulders and tabular mudstone clasts up to 2.5m (Plate 6.5a). The framework varies, becoming dispersed towards the centre of the channel. Clast size also decreases towards the channel centre. Fabric study of this conglomerate showed the presence of a steeply dipping upcurrent imbrication and a pronounced orientation of the A axes transverse to the inferred flow direction. The direction of flow indicated by the fabric is essentially towards 080° (Table 4.1). Sole marks on adjacent sandstones indicate flow towards 130° - 140° (Table 2.1). No orientation of the channel itself could be obtained, but presumably the conglomerate fabric closely parallels the channel axis.

F. LATERAL VARIATION WITHIN THE KEEPIT CONGLOMERATE

Fig. 6.6 shows the variation in average section thickness, lithology percentages and clast sizes for the terrestial domain and the three subdivisions of the marine domain (see also Figs. 2.2,2.3,2.4). It must be noted that the section thicknesses used are the actual measured thicknesses (p. 22). Similarly, the lithology percentages are the percentages of conglomerate, pebbly sandstone/sandstone and mudstone which actually outcrop (p.24). The clast size data include the maximum clast size (A axis) recorded for any clast lithology, but excluding intraformational clasts, and the average of the 10 largest volcanic clasts for each section (p. 24).

1. Thickness:

A general trend of decreasing thickness from the terrestial domain in the west to subdivision III of the marine domain in the east is evident. The initial decrease in thickness between the two domains is very marked. A modification to the general trend is presented by subdivision I of the marine domain which is thinner than the more easterly subdivisions II and III. This may in part reflect the fact that two of the three sections described from subdivision II are incomplete (MS8, MS9). It may also result from the thick sections of subdivision II in the Somerton and Timor areas biasing the average thickness for subdivision II. In the Caroda area, the thickness values for sections of Subdivision II and III are much less and more comparable to those of Subdivision I (Appendix I). However, on averaging only these sections, Subdivision I still provides a lower value.

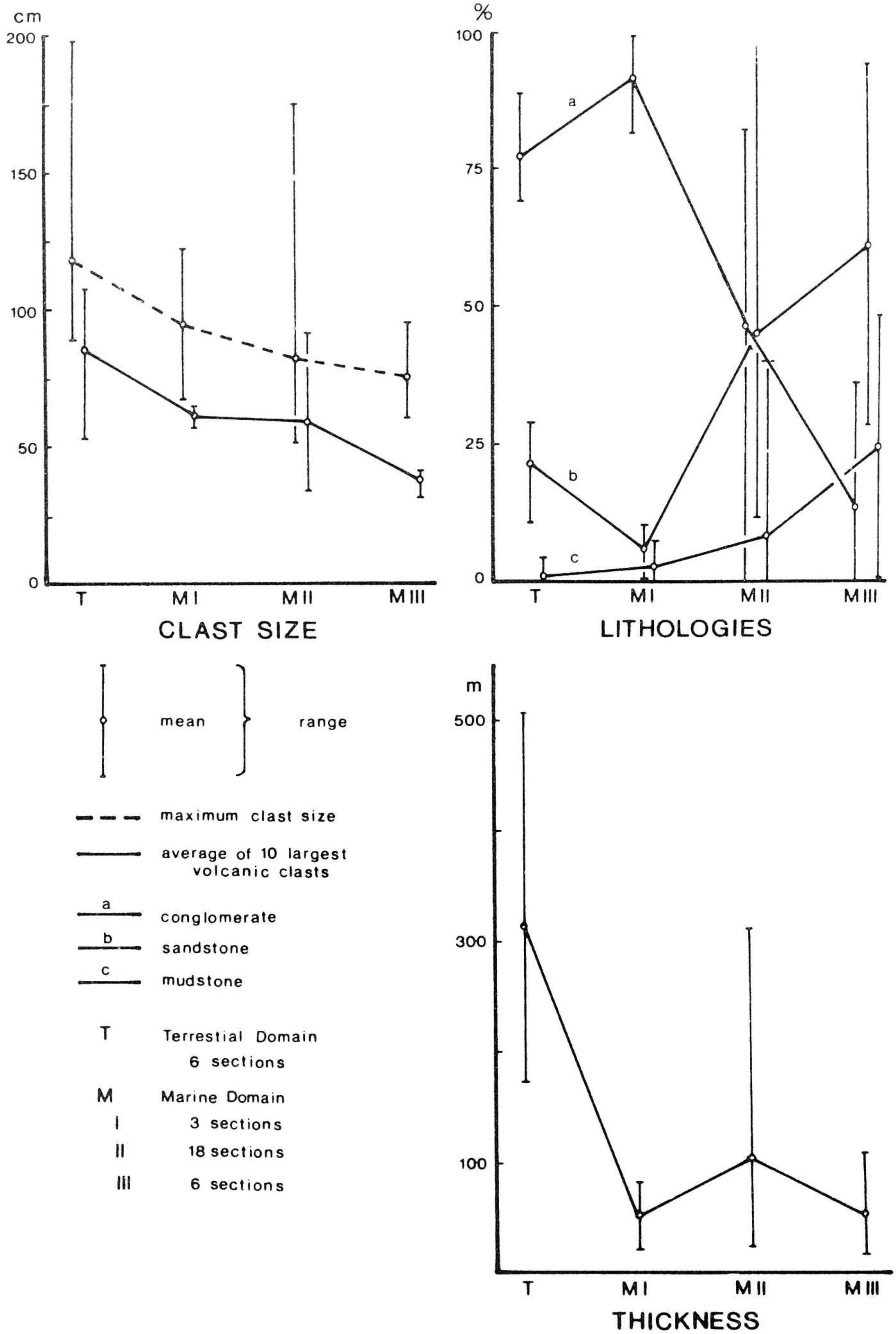
2. Lithologies:

There is a general trend for conglomerate to decrease in quantity from the terrestial domain in the west to subdivision three of the marine domain in the east. This is paralleled by increasing quantities of pebbly sandstone/sandstone and mudstone in the same west to east direction. A modification superimposed upon the regional trend is presented again by subdivision I, which has an extremely high conglomerate content and a correspondingly markedly low pebbly sandstone/sandstone content.

Fig. 6.6.

Variation in average clast size, lithologies and thickness for the terrestial domain and the three subdivisions of the marine domain. Both the mean and the range in values for each area are indicated.

Note the overall trends of decreasing clast size, conglomerate percentage and thickness and increasing sandstone and mudstone contents from the terrestial domain in the west to subdivision III of the marine domain in the east. Subdivision II departs somewhat from this trend, with respect to conglomerate and sandstone content and thickness.



cm
200
150
100
50
0
T
M I
M II
M III
CLAST SIZE
%
100
75
50
25
0
a
b
c
LITHOLOGIES
m
500
300
100
THICKNESS
mean
range
maximum clast size
average of 10 largest volcanic clasts
a conglomerate
b sandstone
c mudstone
T Terrestial Domain 6 sections
M Marine Domain
I 3 sections
II 18 sections
III 6 sections

3. Clast Size:

The values for both the maximum clast size and the average of the "10 largest volcanic clasts" size exhibit a decrease from the terrestial domain in the west to subdivision III of the marine domain in the east. This trend represents decreasing quantities of boulder grade detritus within the more easterly (distal) conglomerate occurrences. Such reflects decreasing competence of the transporting mechanisms.

G. SUMMARY

1. Both terrestial and marine domains of sedimentation have been recognised within the Keepit Conglomerate. Within these two domains, a total of 16 distinct facies have been recognised and described.

2. Interfingering of the terrestial and marine domains may be seen in MS25.

3. Within the marine domain three subdivisions have been recognised. Due to greater homogeneity over more limited outcrop area, subdivision of the terrestial domain has not been possible.

4. A palaeogeographic distribution is clearly evident, with the terrestial domain occurring on the western margin of the Tamworth Belt and the three subdivisions of the marine domain occurring, in general, progressively eastward in the order I, II, III.

5. Accompanying this distribution is a progressive decrease in clast size, and a general trend for decreasing thickness and conglomerate content coupled with increasing sandstone and mudstone content from west to east. Subdivision I departs from this general trend.

6. The distribution of the domains and subdivisions, and the trends between them, indicate, from west to east, progressively more distal sedimentation conditions for the Keepit Conglomerate. This suggests a western source area and an easterly dipping palaeoslope. Such is in agreement with the palaeocurrent data (p.26).