CHAPTER 2

THE GENERAL GEOLOGY OF THE KEEPIT CONGLOMERATE

A. THE KEEPIT CONGLOMERATE

1. Introduction:

The Keepit Conglomerate was first named by Voisey and Williams (1964) from the Lake Keepit region. They defined it as a member within their Late Devonian Manilla Group. The unit was raised to formational status by White (1964c), working further east in the Somerton-Attunga area. Its regional extent became rapidly defined through the work of Leslie (1963), White (1964a,b,c; 1965,1966), McKelvey and White (1964) and McKelvey (1966,1968).

Earlier stratigraphic studies relating to the Keepit Conglomerate were few. Carey recognised an interval of "quasi-volcanic conglomerates ..... about 800 feet in thickness" (Carey, 1937, pp.349-350), now known to be the Keepit Conglomerate (Voisey and Williams, 1964), at the top of his Late Devonian Barraba Series. Lloyd (1934) had previously included this unit as the basal horizon of the Carboniferous Burindi Series (see map p.90 of Lloyd, 1934). Earlier still, comments on the Keepit Conglomerate had been made by Andrews (1915) and Pittman (1898) in connection with site investigations for Keepit Dam.

The Keepit Conglomerate was shown by White (1964a,b,c) to be synonymous with the upper levels of the Baldwin Formation as defined and mapped by Crook (1961b) and Chappell (1961). It is not, however, synonymous with the upper levels of the Baldwin Formation of Voisey (1958a,b). Neither Voisey, Chappell nor Crook had recognised the Keepit Conglomerate in their studies. It must also be noted that the upper horizons of the Baldwin Formation of Crook (1961b) need not everywhere be considered to be the Keepit Conglomerate (see p.18).

In the Timor Valley the Keepit Conglomerate was included within the Middle Devonian Tamworth Series of Osborne *et al.* (1948, p.314) as "coarse albitic breccia, blue fine tuff, conglomerate abruptly changing in character" (Manser, 1967, p.20). The Keepit Conglomerate was first mapped in detail in this region by Manser (1967,1968) who gave to it the name Balarang Conglomerate and correlated it with the Keepit Conglomerate

of White (1964c). The name Keepit Conglomerate was used in preference to Balarang Conglomerate by Ellenor (1971) in a study of the Timor Valley sequence. This usage is herein followed.

2. Definition of the Keepit Conglomerate:

The Keepit Conglomerate is a thick, extensive Late Devonian unit within the Tamworth Belt of northeastern New South Wales. It consists mainly of polymictic pebble-cobble conglomerates, less common lithofeldspathic sandstones, and subordinate mudstones. All are primarily of volcanic provenance.

The Keepit Conglomerate overlies the Late Devonian Baldwin Formation, or the lithostratigraphically equivalent Eungai Mudstone or Lowana Formation, with either a disconformable or a conformable contact. The Keepit Conglomerate is considered to disconformably overlie the Middle Devonian Yarrimie Formation in the Timor Valley (Manser, 1967; Ellenor, 1971). The Late Devonian Mandowa Mudstone conformably overlies the Keepit Conglomerate. South of Lake Keepit, at MS31, the Early Carboniferous Tulcumba Sandstone disconformably overlies the Keepit Conglomerate (Moore, 1974).

When exposed, the contacts are easily identified. The base of the Keepit Conglomerate in areas of disconformity is usually a conglomerate or a coarse often pebbly sandstone. In areas of conformity the base is taken as the base of the first thick bedded sandstone. The upper limit of the Keepit Conglomerate may be either abrupt or gradational. The contact is taken as the top of either the last conglomerate or the last thick bedded sandstone.

3. Derivation:

Keepit Dam (Voisey and Williams, 1964, p.67).

4. Type Section:

The southern flank of Klori Hill, 400 yards east of Klori Trig. Station (White, 1964c, pp.206-207). Klori Trig. is located 18.5 kilometres to the east of Keepit Dam (Fig. 2.1,2.2).

5. Representative Sections:

The locations of the representative sections are included on Fig. 2.2. Grid references for these sections are to be found in Appendix 1. Detailed stratigraphic columns are presented as an enclosure at the back of the thesis. The terrestial and marine domains, to which the representative sections are referred, are discussed in detail in Chapter 6.

a. *Representative Sections for the Terrestial Domain.* MS27, MS29.

b. *Representative Sections for the Marine Domain.* MS7, MS20, MS21, MS39, MS3, MS5, MS13.
MS25 possesses both marine and terrestial deposits.

6. Distribution:

The distribution of the Keepit Conglomerate within the Tamworth Belt is shown in Fig. 2.1. The Keepit Conglomerate occurs as a series of discontinuous outcrops extending from MS1 west of Bingara, to the vicinity of Moonan Flat, a distance of 232 kilometres. The greatest east-west extent is 26 kilometres in the Lake Keepit-Attunga area.

In the north of the Tamworth Belt the Keepit Conglomerate extends from MS1 to south of Barraba (MS14, Fig. 2.2), as a number of short fault bounded strips. Exact relationships between these strips are unknown. In the Lake Keepit-Attunga area the Keepit Conglomerate is exposed on the limbs of a series of gently plunging, NNW-SSE trending, faulted synclines and anticlines. The Lake Keepit area is the only part of the Tamworth Belt where the Keepit Conglomerate is exposed on the western limb of the prominent Rocky Creek-Werrie Syncline, containing predominantly Carboniferous lithologies.

The region extending south from Somerton-Tamworth to the Liverpool Range is mapped as containing a relatively continuous belt of Keepit Conglomerate (White, 1964a,c; Offenberg, 1971). This is a southern continuation of the Keepit Conglomerate in the Somerton-Attunga area. Extremely poor outcrop has prevented detailed sections being measured in this region. Isolated outcrops mapped as Keepit Conglomerate have been examined. To the east, near Nundle, mapped occurrences of the Keepit Conglomerate (Offenberg, 1971) reflect the attempt to fit the stratigraphy

Fig. 2.1

Map of that part of the Tamworth Belt covered in this study showing the outcrop extent of Devonian, Carboniferous and Permian strata, and the distribution of the Keepit Conglomerate. Localities and structural features referred to in the text are also shown.

To the north the Tamworth Belt passes beneath Mesozoic strata of the Great Artesian Basin. The Nandewar Range and the Liverpool Range consist of Tertiary volcanics covering parts of the Tamworth Belt sequence.

The map is taken from the New England 1:500,000 Geological Sheet. The location of this figure with respect to the New England Fold Belt and Sydney Basin may be seen by reference to Fig. 1.1.

This figure is used as a base for subsequent figures.

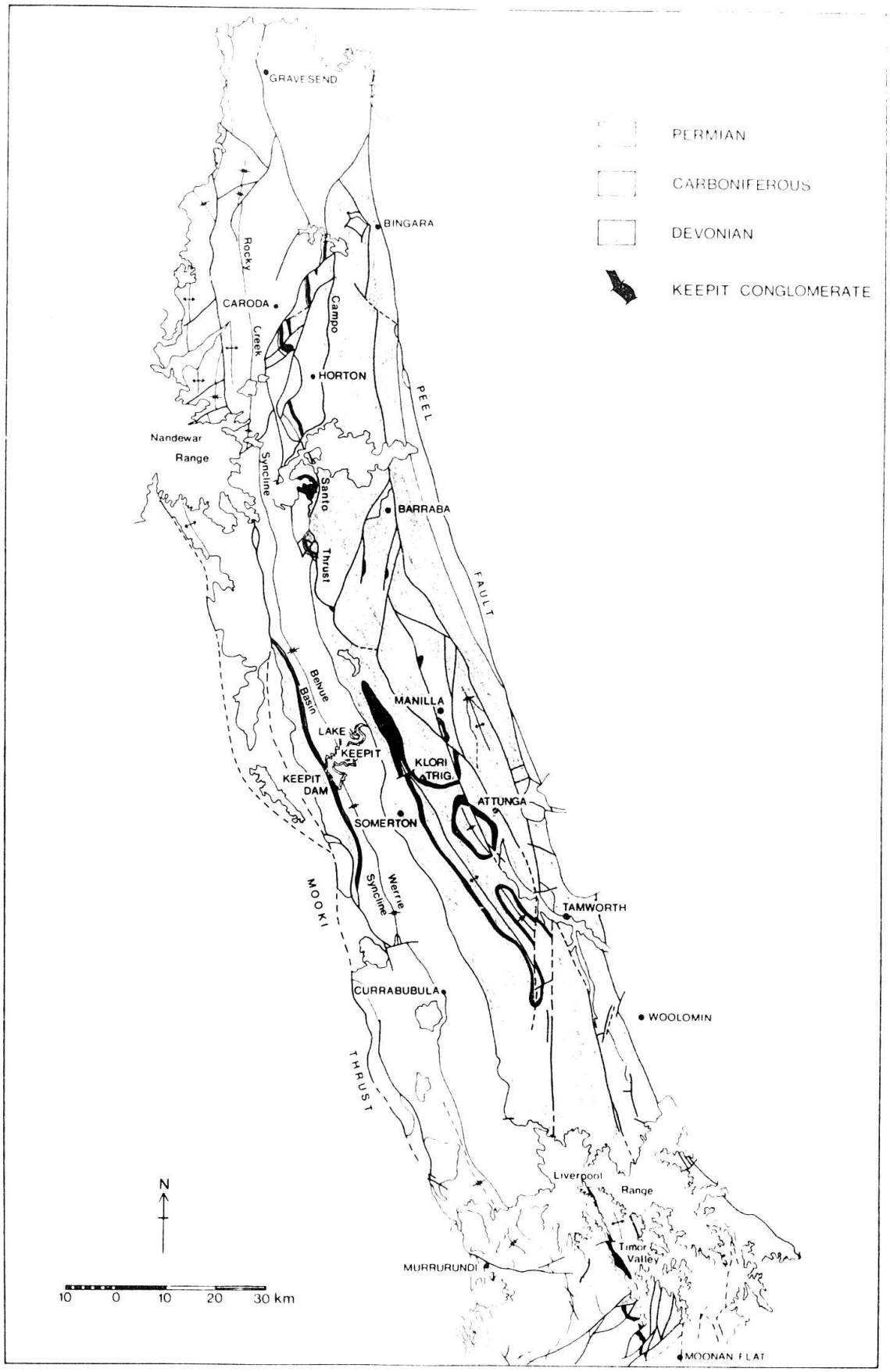

PERMIAN
CARBONIFEROUS
DEVONIAN
KEEPIT CONGLOMERATE
GRAVESEND
BINGARA
CARODA
Rocky
Creek
Campo
HORTON
PEEL
FAULT
Nandewar
Range
Syncline
Santo
Thrust
BARRABA
Belvue
Basin
MANILLA
LAKE
KEEPIT
KLORI
TRIG.
KEEPIT
DAM
ATTUNGA
SOMERTON
Werrie
Syncline
MOOKI
TAMWORTH
CURRABUBULA
WOOLOMIN
THRUST
Liverpool
Range
Timor
Valley
MURRURUNDI
MOONAN FLAT
N
10 0 10 20 30 km

Fig. 2.2. Section Locations and Thickness Values for the Keepit Conglomerate

Distribution of the Keepit Conglomerate showing:

(1) locations and numbers of measured sections (prefixed in the text by MS, e.g., MS17),

(2) thickness values for the measured sections,

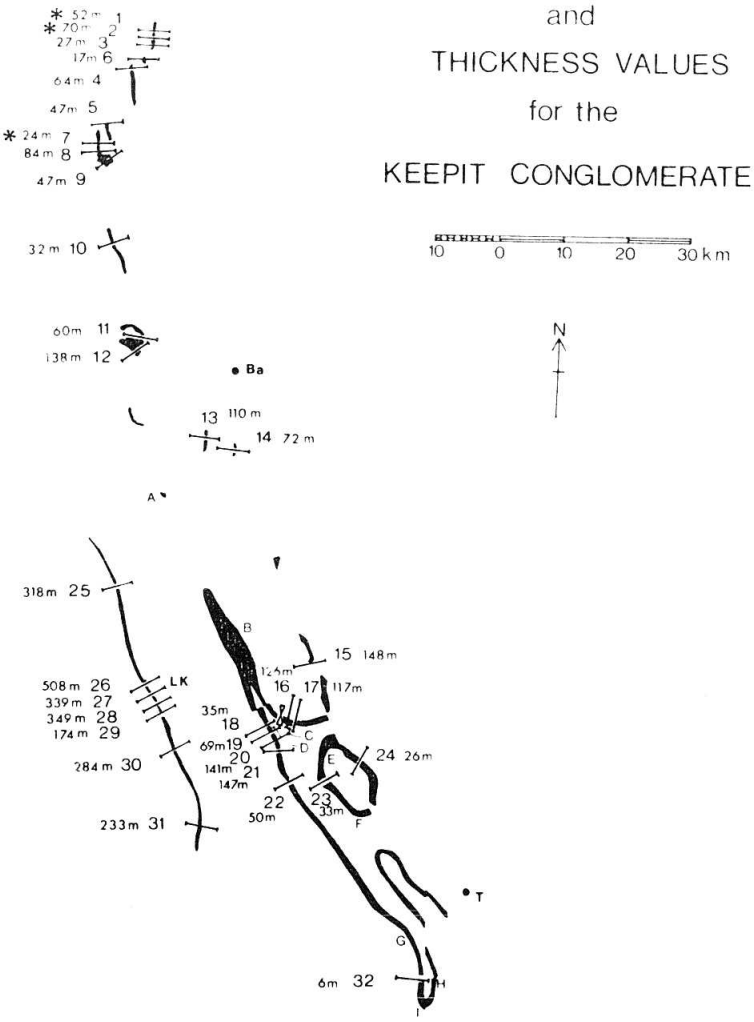
(3) localities referred to in the text,

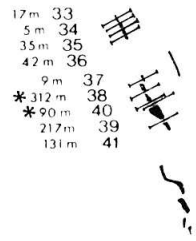
(4) the type section of the Keepit Conglomerate.

Those sections marked with an asterisk have both the upper and the lower contacts exposed. For many sections, only one contact is exposed.

Figure 2.1 is used as a base for this figure.

SECTION LOCATIONS and THICKNESS VALUES for the KEEPIT CONGLOMERATE





7 Measured Section

349 m Section Thickness

Type Section of the Keepit Conglomerate

* Base and Top both exposed

A Locality

of White (1964c) to the mapping and stratigraphy of Crook (1959a,1961b). The Keepit Conglomerate is unproven as such in the Nundle area.

A broad belt of Keepit Conglomerate outcrop to the north of Klori Trig. reflects a plunging anticline. Inadequate exposures throughout much of this area, due to poor outcrop and the structural controls, has prevented the measuring of useful sections.

South of the Liverpool Range the Keepit Conglomerate occurs best developed on the western limb of the Timor Anticline, and as several short fault bounded strips extending south to near Moonan Flat.

a. The Distribution of the Keepit Conglomerate in the Lake Keepit Area.

To the north of Lake Keepit, Voisey and Williams (1964) and subsequent geological maps show the Keepit Conglomerate and overlying Mandowa Mudstone truncated by the overlying Tulcumba Sandstone. 13km to the north of this supposed truncation I have described a previously unrecorded Keepit Conglomerate occurrence (MS25). In view of this occurrence, and in the absence in these grass covered low hills of unequivocal evidence for the erosional termination of Voisey and Williams, the Keepit Conglomerate is shown herein as a continuous belt extending north to, and somewhat beyond, the location of MS25 (Fig. 2.2).

b. The Distribution of the Keepit Conglomerate in the Caroda Area.

In the Caroda area, the Keepit Conglomerate of MS5 is considered to lie upon a lower stratigraphic level than the outcrop belt containing sections MS7 and MS8. This is in contrast to previous interpretations (McKelvey, 1966; McKelvey and White, 1964) in which both horizons were considered to be on the same stratigraphic level. My interpretation is based upon the markedly different facies present and the occurrence of a thick sequence of mudstones between the two horizons. No evidence exists for repetition by folding or faulting. Further to the east, a thick sandstone sequence (MS6) occurs within the Eungai Mudstone beneath, and separated from by a thick mudstone sequence, the Keepit Conglomerate. With respect to these sandstones, McKelvey (1966, p. 2.34) states "The limited data available .... suggests these rocks to be virtually indistinguishable in thin section from the Keepit Conglomerate lithologies". These sandstones are herein considered to be lateral equivalents of the lithologies of MS5. Thus, within the Caroda area, two phases of Keepit Conglomerate sedimentation,

separated by a thick interval of mudstones, are recognised. On the basis of the facies present the earlier horizon represents a lesser basinward advance (more distal conditions) than the later horizon.

7. Thickness:

The greatest thickness value recorded for the Keepit Conglomerate is >508 metres from MS26, north of Lake Keepit in the west of the Tamworth Belt. The thinnest complete section is 24 metres from MS7 near Caroda. The general form of the Keepit Conglomerate, on the basis of the thickness data, appears to be of a number of now fault displaced fanlike bodies exhibiting both lateral thickening and thinning, and an eastward or basinward thinning.

The thickness values (Fig. 2.2, Appendix 1) for detailed sections through the Keepit Conglomerate were obtained by either Jacob Staff or by tape and compass traverse. Of the measured sections only about 22% are complete in having both upper and lower contacts exposed. Many sections have only one contact well exposed. About 32% of the sections are relatively isolated occurrences of the Keepit Conglomerate and for these no reliable estimate may be made as to actual thickness. In many sections a reasonable estimate of maximum thickness may be obtained as only small intervals in the region of the contact are unexposed. It is stressed that the thickness values presented in Fig. 2.2 are predominantly minimum values: those complete sections are indicated upon Fig. 2.2 by an asterisk.

The faulted nature of the distribution of the Keepit Conglomerate, plus the lack of many complete sections, precludes a more detailed analysis of the thickness data. The fanlike form is best illustrated by the sections in the Lake Keepit-Somerton-Attunga region. Sections in the Timor Valley also show this fanlike form. The faulted outcrop pattern, many incomplete sections, and the complete lack of marker horizons within the Keepit Conglomerate which could assist in correlation between these fault strips, have prevented a meaningful analysis of the thickness of the sections in the northern portion of the belt.

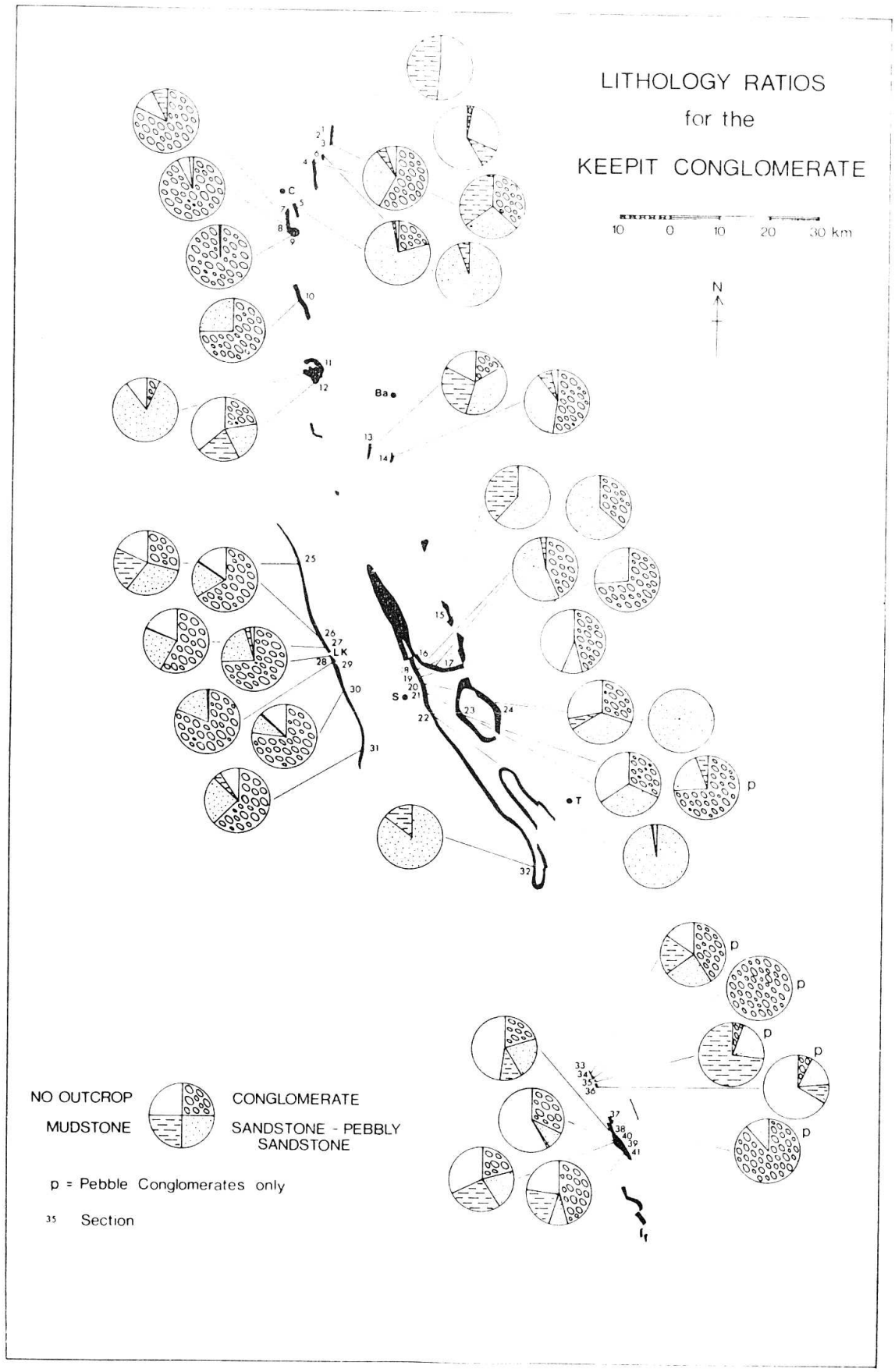
8. Principle Lithologies:

An average of the lithology percentages for all measured

Fig. 2.3. Lithology Ratios for the Keepit Conglomerate

Distribution of the Keepit Conglomerate showing the ratios of conglomerate, sandstone-pebbly sandstone, mudstone, and no outcrop for each measured section. The amount of no outcrop within each section is included as a reliability factor. Also indicated is those sections in which the conglomerate is solely of pebble grade.

This figure should be examined in association with Fig. 2.4.


LITHOLOGY RATIOS
for the
KEEPIT CONGLOMERATE
10 0 10 20 30 km
N
C
Ba
LK
S
T
p
NO OUTCROP
MUDSTONE
CONGLOMERATE
SANDSTONE - PEBBLY SANDSTONE
p = Pebble Conglomerates only
35 Section

sections (41) shows the Keepit Conglomerate to consist of 47.8% conglomerate, 39.5% sandstone and 12.8% mudstone. The percentages of conglomerate, sandstone and mudstone within individual measured sections of the Keepit Conglomerate are shown diagrammatically in Fig. 2.3. The percentage of no outcrop within the measured interval is also shown. Unfortunately, no reliable indication may be obtained as to the most probable rock type(s) occupying these intervals. Rubble within soils suggests either conglomerate, sandstone or mudstone may occur as the non-outcropping lithology.

The conglomerates, predominantly clast supported, range from pebble to boulder with pebble and/or cobble grades the more common. Matrix supported conglomerates occur as subordinate discrete units or as gradational intervals between clast supported conglomerate and pebbly sandstone. Matrices are predominantly sandstone. In some matrix-supported conglomerates muddy sandstone matrices may be present. Diamictites, in the sense of Flint *et al.* (1960), are rare. The clasts range in size up to a maximum recorded A axis of 198 cm (MS28), and are predominantly rounded (Chapter 5).

The sandstones are essentially matrix free and variable in grain size. Coarser varieties are often pebbly and may grade laterally or vertically to conglomerate. The sandstones occur as lenses within the conglomerate or as discrete units interbedded with conglomerate and/or mudstone. The mudstones may be massive or laminated. They occur as intervals interbedded with the conglomerate and/or sandstone or as thin to very thin beds within sandstone beds. The various facies recognised within the Keepit Conglomerate are described in detail in Chapter 6.

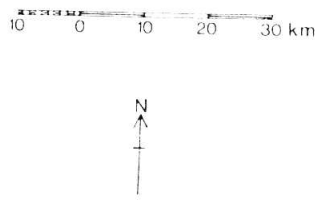
Inspection of Fig. 2.3 shows that in general the sections to the west possess a greater percentage of conglomerate than those to the east. In addition, mudstone is usually more common in the more eastern sections. It must be noted, however, that many of the sections are incomplete and hence Fig. 2.3 represents in many instances the percentages of lithologies which actually outcrop.

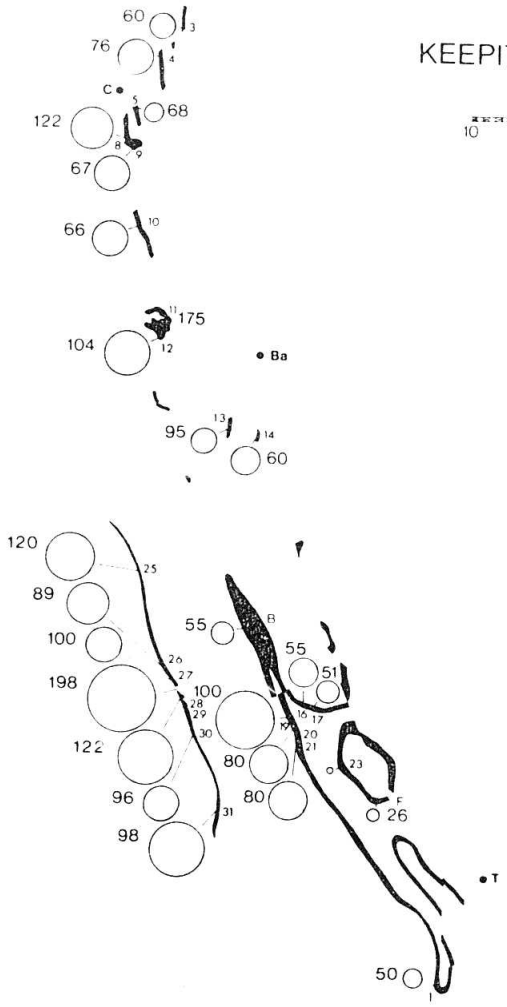
Complementing the eastward decrease in conglomerate is an eastward decrease in clast size (Fig. 2.4). The clast size data includes both the maximum clast size (A axis) recorded for any clast lithology, but excluding intraformational clasts, and the average of the ten largest

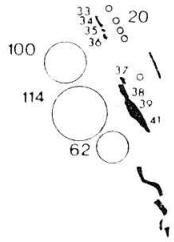
Fig. 2.4. Clast Sizes for the Keepit Conglomerate

Distribution of the Keepit Conglomerate showing the variation in maximum clast size and the "average of the 10 largest volcanics" clast size.

CLAST SIZES
for the
KEEPIT CONGLOMERATE







198 Maximum Clast Size

Average Clast Size

100 cm

Average Size = Pebble Grade

25 F Section, Locality

volcanic clasts for each section. In order to minimise any effect of varying rate of wear between different lithologies, the overwhelmingly predominant volcanic clasts, essentially all andesitic, were used to calculate the average maximum diameter of the ten largest clasts. The values for both the maximum clast size and the average of the "ten largest volcanic clasts" size exhibit a decrease from west to east, indicating decreasing quantities of boulder grade detritus within the more easterly conglomerate occurrences. In several instances, high conglomerate contents in more easterly sections represent only pebble grade conglomerates (Fig. 2.3).

9. Palaeocurrents:

The available palaeocurrent data for the Keepit Conglomerate (Fig. 2.5, Table 2.1) suggests a flow direction essentially from west to east, i.e. from basin edge to basin axis, indicating a westerly source and an easterly dipping palaeoslope. This is in accord with both the previous limited palaeocurrent data for the Keepit Conglomerate (White, 1966; Manser, 1967), and the palaeocurrent data for the Tamworth Belt sequence in general (Crook, 1964; White, 1966; Manser, 1967; Moore and Roberts, 1976).

Approximately half of the palaeocurrent data comes from fabric studies. The results of these studies are discussed in more detail in Chapter 4. The remainder comes from occasional occurrences of sole markings, scour channels, cross stratification and ripples. Individual localities may possess palaeocurrent directions spread over 90° (MS14, MS20, MS21), suggestive of locally radiating flow directions.

10. Age of the Keepit Conglomerate:

The Keepit Conglomerate is of Famennian age. This is based on evidence, discussed below, from the formations above and below the Keepit Conglomerate. The Keepit Conglomerate itself is poorly fossiliferous.

The best evidence for the age of the Keepit Conglomerate comes from Lake Keepit where Famennian ammonoids have been recovered from the underlying Baldwin Formation (Jenkins, 1966) and the overlying Mandowa Mudstone (Jenkins, 1968). To the east, Famennian ammonoids have been reported from the Baldwin Formation just below the base of the Keepit

Fig. 2.5. Palaeocurrent Directions for the Keepit Conglomerate

Distribution of the Keepit Conglomerate showing palaeocurrent directions. The structures from which the data were derived are indicated. Limited data from White (1966) and Manser (1967) is also plotted.

PALAEOCURRENT DIRECTIONS for the KEEPIT CONGLOMERATE

Structures

- f Flute casts
- t Tool casts
- x Cross stratification
- r Ripples
- sc Scours
- c Conglomerate fabric
- p Plant fragment orientation
- s Shale clast orientation

Directional Structure

Non - directional Structure

Data from White (1966) & Manser (1967)

35 C Section, Locality

Table 2.1. Palaeocurrent Data for the Keenit Conglomerate

Section	Data Source	Palaeocurrent direction or trend	
MS1	flute casts	121°	
MS3	conglomerate fabric	ESE	*
	flute casts	055°	
	conglomerate fabric	E	After White (1966)
MS4	conglomerate fabric	ESE	
MS5	conglomerate fabric	E	
	flute casts	137°	
	tool casts	310°-130°	
	diamictite fabric	NNW-SSE	
MS8	conglomerate fabric	NW	
	conglomerate fabric	NW	
MS9	conglomerate fabric	SSE	
MS12	conglomerate fabric	NE	
	conglomerate fabric	E	After White (1966)
	conglomerate fabric	ESE	After White (1966)
MS14	conglomerate fabric	SE	
	ripples	057°	
MS15	tool casts	208°-028°	
loc.C	cross stratification	047°	
MS20	flute casts	105°	
	tool casts	285°-105°	
	ripples	115°	
	A' fabric, imbrication	NE	
MS21	conglomerate fabric	SSE	
	A' fabric, imbrication	ENE	
MS22	shale clast fabric	345°-165°	Flow direction assumed to transverse to shale clast and plant fragment fabric, see p. 87, Chapter 4, and Fig.2.5.
	plant fragment fabric	030°-210°	
MS24	shale clast fabric	345°-165°	
MS25	cross stratification	032°	
	scour channel	036°	

Table 2.1 (continued)

Section	Data Source	Palaeocurrent direction or trend	
MS27	scour channel	070°	
MS28	conglomerate fabric	NE	
	ripples	120°	
MS29	conglomerate fabric	NE	
	conglomerate fabric	NE	
MS31	conglomerate fabric	NNE	
	ripples	067°	
MS36	cross stratification	055°	
MS39	conglomerate fabric	NE	
	sole marks	130°	After Manser (1967)
	cross stratification	130°	After Manser (1967)

* Conglomerate fabric data are given in this table as a general direction; for stereonets, vector means and discussion of results see Chapter 4.

Conglomerate and from the Kiah Limestone Member of the Mandowa Mudstone (Pickett, 1960). The Keepit Conglomerate is thus Famennian in age and would lie within the interval toII to toIV (Roberts *et al.* 1972). If the poorly preserved specimen of *Platyclymenia* from the Baldwin Formation (Pickett, 1960) was correctly identified then the Baldwin Formation extends into toIV, and the Keepit Conglomerate would, in the area of the fossil locality, fall wholly within this interval (Roberts *et al.* 1972).

The most common fossil type within the Keepit Conglomerate is plant debris and includes *Leptophloeum australe*, usually indicative of a Late Devonian age (Gould, 1975). Marine macrofossils are scarce and usually consist of abraded crinoid, brachiopod and gastropod remains. Small unidentifiable brachiopods have been found in MS10. A clast containing cladoxylalean plant fossils, indicative of a Middle Devonian to Late Carboniferous age (Scheckler, 1974, p.463), was recovered from MS9.

Plate 2.1

a. Largest boulder observed within the Keepit Conglomerate. An andesitic clast with a maximum diameter of 1.98 metres. Ends indicated by arrows. MS28.

b. Cluster of rounded boulders within a clast supported pebble-cobble conglomerate. MS29.

c. Clast supported pebble-cobble conglomerate. Note clast rounding and imbrication. MS39.

d. Disconformable contact between terrestial cobble-boulder conglomerate of the Keepit Conglomerate and marine mudstones of the Baldwin Formation. MS27.

e. Gradational conformable contact from Eungai mudstone to marine Keepit Conglomerate, with Keepit Conglomerate-type sandstones and Eungai mudstone-type mudstones. Thick bedded sandstones appear behind the dog. MS2.

f. Abrupt conformable contact between thick marine sandstone of Keepit Conglomerate and mudstone sequence of Eungai mudstone. MS6.

g. Disconformable contact between marine sandstones of the Keepit Conglomerate and mudstones-sandstones of the Baldwin Formation. West of MS17.

h. Disconformable contact between marine conglomerates of the Keepit Conglomerate and the Eungai mudstone. MS9.

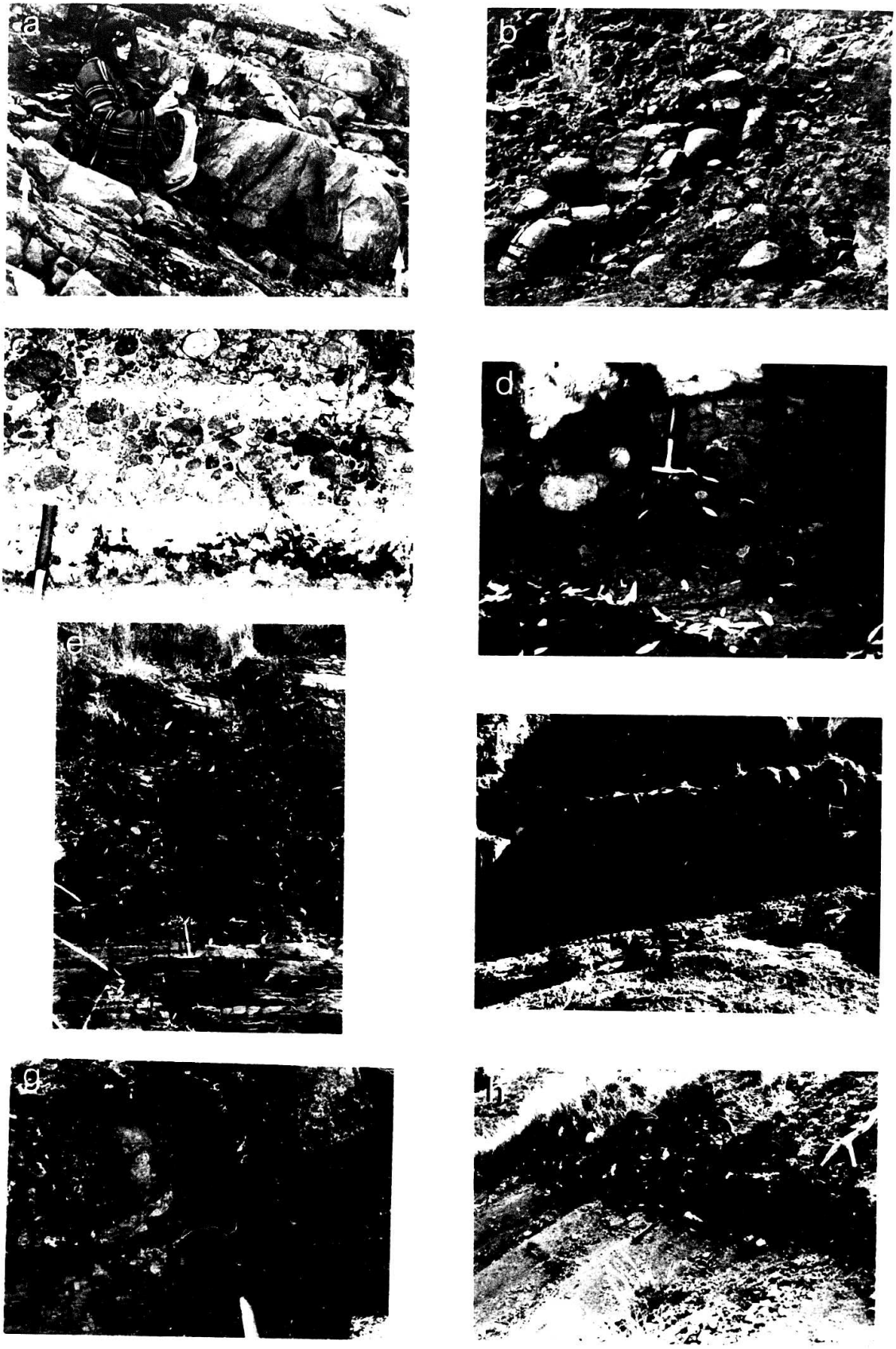


Plate 2.1