PAC STRATIGRAPHY OF THE BINNEWATER, RONDOUT AND MANLIUS FORMATIONS OF THE HUDSON VALLEY

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INTRODUCTION

The purpose of this trip is to present a demonstration of field application of the PAC hypothesis. Specific objectives include:

1. demonstration of criteria for recognition of PACs in a variety of facies (all STOPS);

2. field checking of stratigraphic columns described in terms of PACs (all STOPS);

3. illustration and discussion of methods of correlation of PACs (all STOPS);

4. demonstration of a major cryptic unconformity at the Manlius-Coeymans boundary (STOPS 1, 2, 3 and 6);

5. demonstration of a minor cryptic unconformity at the PAC 3-5 boundary (STOPS 1, 4 and 6);

6. demonstration of lateral facies change within a PAC (e.g. PAC 9, STOPS 1, 2, 3 and 6);

7. demonstration of episodic onlap over the Ordovician land surface (STOPS 1, 4, 5 AND 6).

THE PAC HYPOTHESIS

The PAC hypothesis (Goodwin and Anderson, 1985) is a comprehensive stratigraphic model which states that most stratigraphic accumulation occurs episodically as thin (less than 5 meters thick), generally shallowing-upward cycles characterized by internal vertical and lateral facies continuity (i.e. conjunct facies relationships). Cycle boundaries, defined by abrupt facies change to disjunct facies, are created by what stratigraphically appear to be geologically instantaneous relative base-level rises. The PAC motif (punctuation and aggradation) is independent of specific facies and therefore a single PAC may be peritidal at one locality and totally subtidal at another locality. The events which produce PAC boundaries are thought to be sea-level fluctuations. Because such events are allogenic, PAC boundaries are essentially synchronous surfaces. PACs are therefore ideal stratigraphic units for intrabasinal correlation and paleogeographic reconstruction.

STRATIGRAPHY OF THE LOWER HELDERBERG GROUP IN THE HUDSON VALLEY

The Binnewater, Rondout and Manlius Formations between Wilbur and Catskill, New York are totally divisible into PACs which can be correlated throughout the study area (Figs. 1 and 2). The general stratigraphic relationships of these formations and their members (Fig. 3) were carefully documented by Rickard (1962). Paleoenvironmental interpretations of these rocks were presented by Waines (1976), Harper (1969) and Laporte (1967 and 1969). An episodic (PAC) stratigraphic interpretation of the formal rock unit boundaries in this area was presented by Anderson, Goodwin and Sobieski (1984) and the cyclic facies architecture and its implications were presented by Osborn (1983), Buggey (1984), Saraka (1984), Goodman (1985) and Goodwin et al. (1986).

In brief summary, the rocks in the study interval represent a diverse set of peritidal and shallow subtidal facies deposited in small-scale allogenic cycles. Correlation and analysis of the distribution of these cycles leads to recognition of a pervasive structure of discontinuities in the lower Helderberg Group. There are not only sedimentologic discontinuities at the bed level but several types of stratigraphic discontinuities (PAC boundaries, small and large scale cryptic unconformities and a traditional angular unconformity).

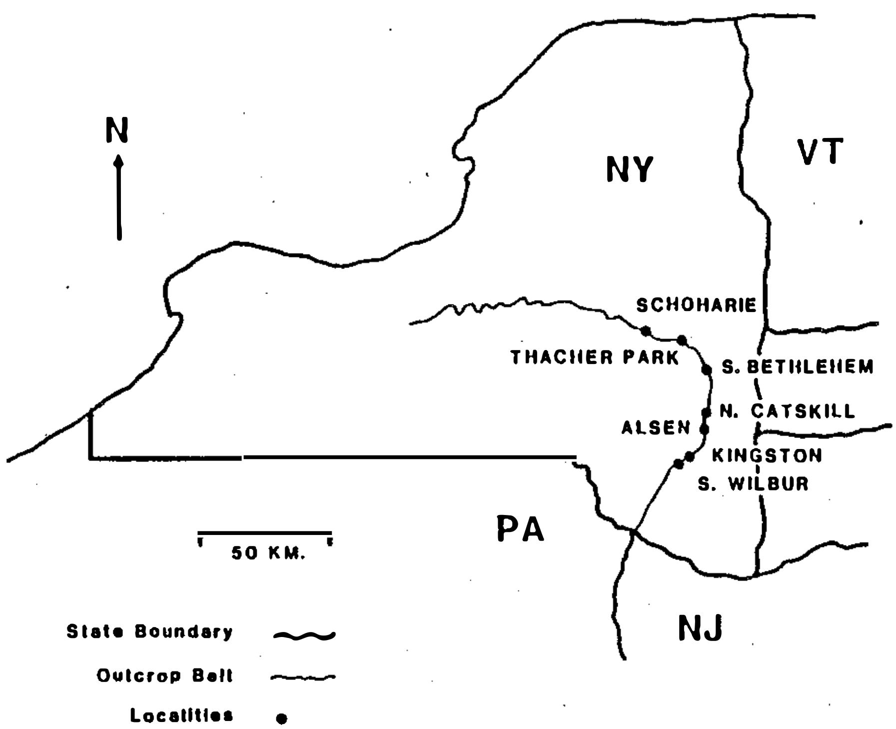


Figure 1. Locality map, Hudson Valley

FIELD TRIP STOPS

STOP 1. NORTH CATSKILL Route 23 exit ramp, .3 miles southwest of New York State Thruway Exit 21.

The Rondout, Manlius, Coeymans and Kalkberg Formations are continuously exposed above an angular unconformity with the Ordovician Normanskill turbidites. The Rondout Formation is made up of 1 PAC and the Manlius contains 10 PACs (PACS 5-14) at this locality (Fig. 2). The Rondout PAC has a subtidal fauna in its base and is topped by a massive supratidal dolomite. The first Manlius PAC has been broken up by tectonism. It is overlain by a peritidal PAC (PAC 6) which is probably similar in facies to the tectonized unit. PACs 7, 8, 11, 13 and 14 are entirely subtidal and PACs 9, 10 and 12 are again peritidal cycles.

In addition to discussing criteria for PAC recognition we would like to focus attention on the following observations at this stop. 1. A major correlation point for Manlius PACs is the facies change from cryptalgal laminites to stromatoporoid bearing calcarenite at the base of PAC 11. We will trace this boundary throughout the study area. 2. The stromatoporoid bearing calcarenite at the base of PAC 9 is replaced laterally by thin-bedded shallow-water carbonate turbidites at Stop 2 and gastropod bearing calcisiltite in the Kingston area (Stops 3 and 6). 3. PAC correlations (Fig. 2) reveal that the Manlius-Coeymans formation boundary is a major cryptic unconformity. To the south at Kingston, PACs 13 and 14 are missing by erosion. To the north and west an additional PAC occurs beneath the unconformity. 4. A minor cryptic unconformity occurs at the boundary between PACs 3 and 5. South of Kingston, PAC 4 is found in this gap. 5. Finally, additional PACs appear below Rondout PAC 3 in the southern localities indicating progressive onlap of the Ordovician land surface.

STOP 2. SOUTH CATSKILL Route 23A, .2 miles southwest of the intersection with Route 9W.

Manlius PACs 6 to 14 are exposed at this locality. The measured section, both overall and cycle by cycle, is nearly identical in thickness to the North Catskill section observed at the last stop (Fig.2). There are two purposes to this stop. 1. We will demonstrate, PAC by PAC, the degree of similarity between two localities two kilometers apart. This analysis is based on PAC correlations. Marked similarity between the two localities is seen in the thick tidal-flat facies in the upper part of PAC 9 and in PAC 10 and in the major facies change to stromatoporoid bearing calcarenite in PAC 11. In addition, the cryptalgal laminite facies with eroded mudcracks on its upper surface at the top of PAC 12 is the same as at North Catskill.

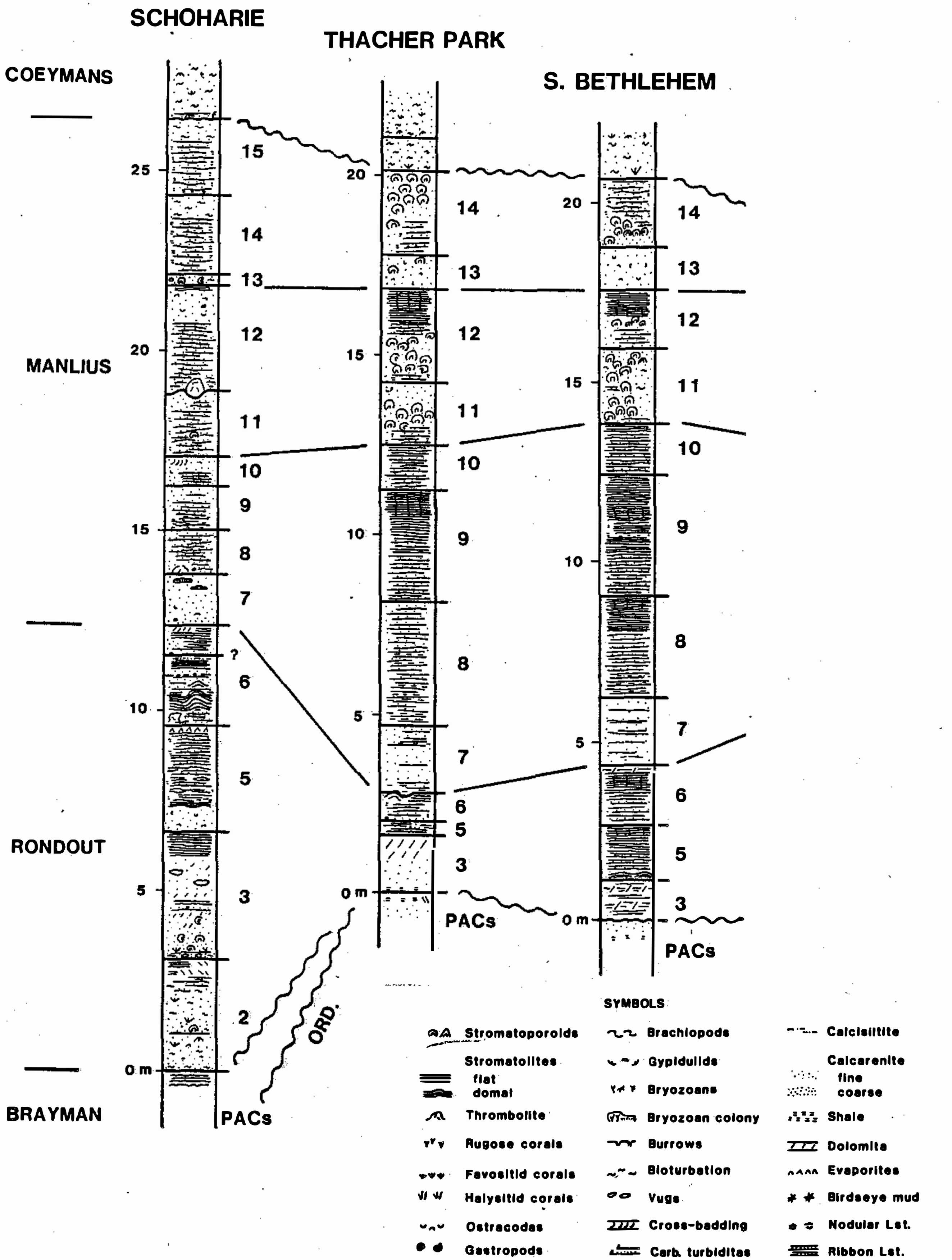
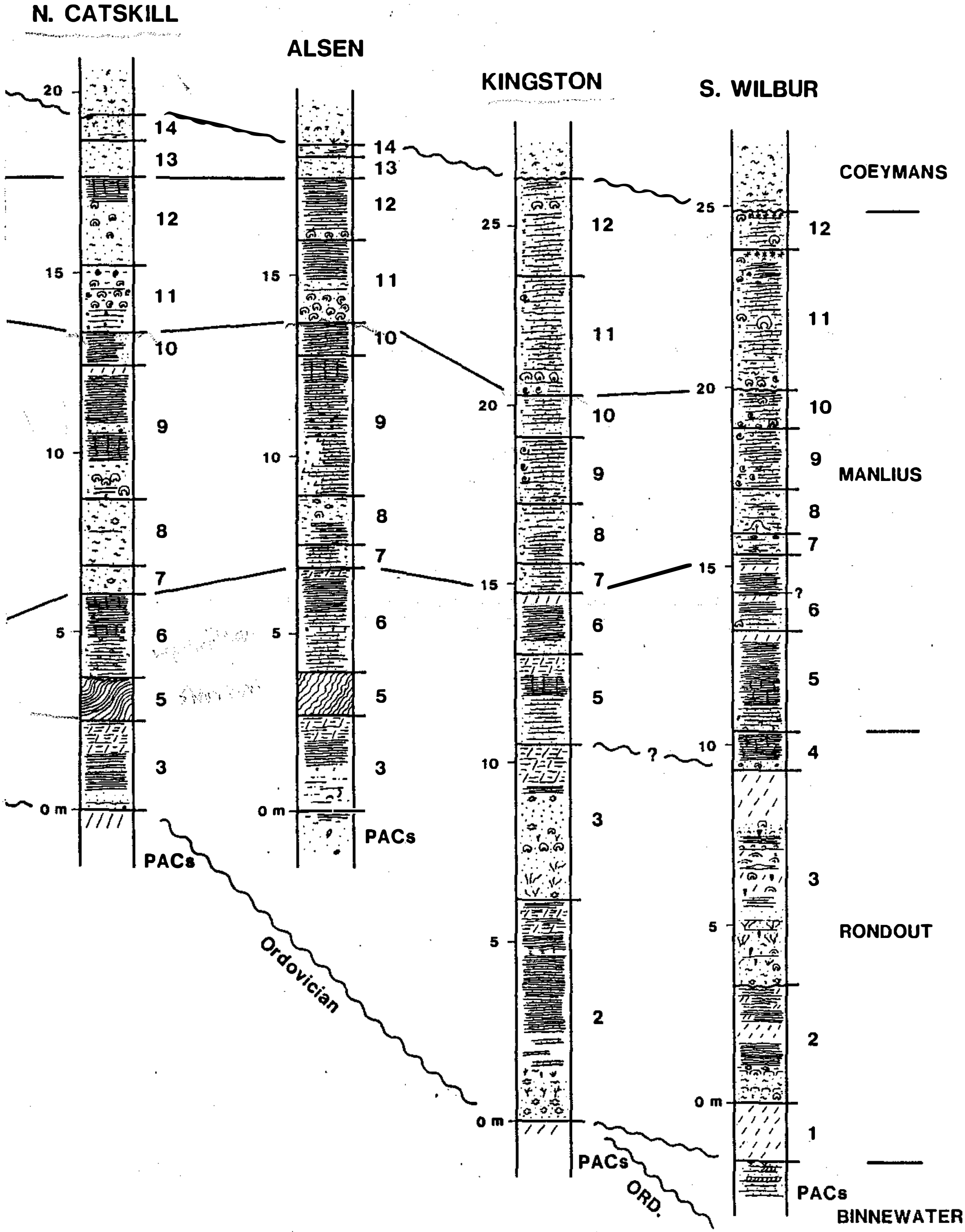


Figure 2. Correlated columns, Hudson Valley, New York (from Goodwin et al., 1986)


N. CATSKILL
ALSEN
KINGSTON
S. WILBUR
COEYMANS
MANLIUS
RONDOUT
BINNEWATER
PACs
PACs
PACs
PACs
Ordovician
ORD.
0 m
0 m
0 m
0 m
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Another primary correlation point is the large facies change from peritidal to subtidal facies at the PAC 5-6 boundary. 2. The second purpose is to demonstrate lateral facies changes within PACs. The boundary between subtidal PACs 7 and 8 is more sharply defined than at the first locality because the calcarenite in PAC 7 is more current washed than at North Catskill. More dramatic lateral facies change within a PAC is illustrated in the base of PAC 9. At this level stromatoporoid bearing calcarenite at North Catskill changes to thin-bedded shallow-water carbonate turbidites.

STOP 3. KINGSTON A Route 199, .5 miles west of the Kingston-Rhinecliff Bridge.

Manlius PACs 7 to 12 are exposed at this locality. In addition to checking PAC definitions, the following observations can be made at this stop. 1. The primary correlation datum is the major facies change to stromatoporoid bearing calcarenite at the base of PAC 11. Also, as at Catskill, a thin cryptalgal laminite facies occurs at the top of PAC 12. 2. If these correlations are correct, PACs 13 and 14 are missing under the first PAC of the Coeymans Formation indicating a progressive enlargement of the cryptic unconformity seen at Catskill. 3. A major lateral facies change has occurred in the PAC 9-10 interval. These PACs are here represented by subtidal gastropod bearing facies while at Catskill we saw two well developed peritidal cycles at this stratigraphic level.

STOP 4. KINGSTON B Route 32, .5 miles south of Route 199.

The top of Rondout PAC 2, Rondout PAC 3 and Manlius PACs 5 and 6 are well exposed at this locality. The following observations can be made at this stop. 1. PACs 5 and 6 are peritidal cycles overlain by the subtidal calcarenite facies of PAC 7. This pattern supports the correlation with the like numbered units at Catskill. 2. As at Catskill, PAC 5 overlies the massive Whiteport Dolomite of PAC 3 (Fig. 4). Also, as at Catskill, PAC 4 is still missing in a minor cryptic unconformity (Fig. 2).

STOP 5. KINGSTON C Route 32, .5 miles south of Stop 4.

Rondout PACS 2 and 3 (the upper part of PAC 3 covered here is fully exposed at the previous stop) overlie Ordovician turbidites of the Normanskill Formation in angular unconformity. PAC 2 (Fig. 2) is represented by the Wilbur and Rosendale Members of the Rondout Formation (Fig. 4) and PAC 3 (Fig. 2) by the Glasco and Whiteport Members (the PAC numbering system, data and interpretations in Figure 4 are taken directly from Osborn's 1983 thesis and differ slightly from those

HELDERBERG STRATIGRAPHY

(modified after Rickard, 1962)

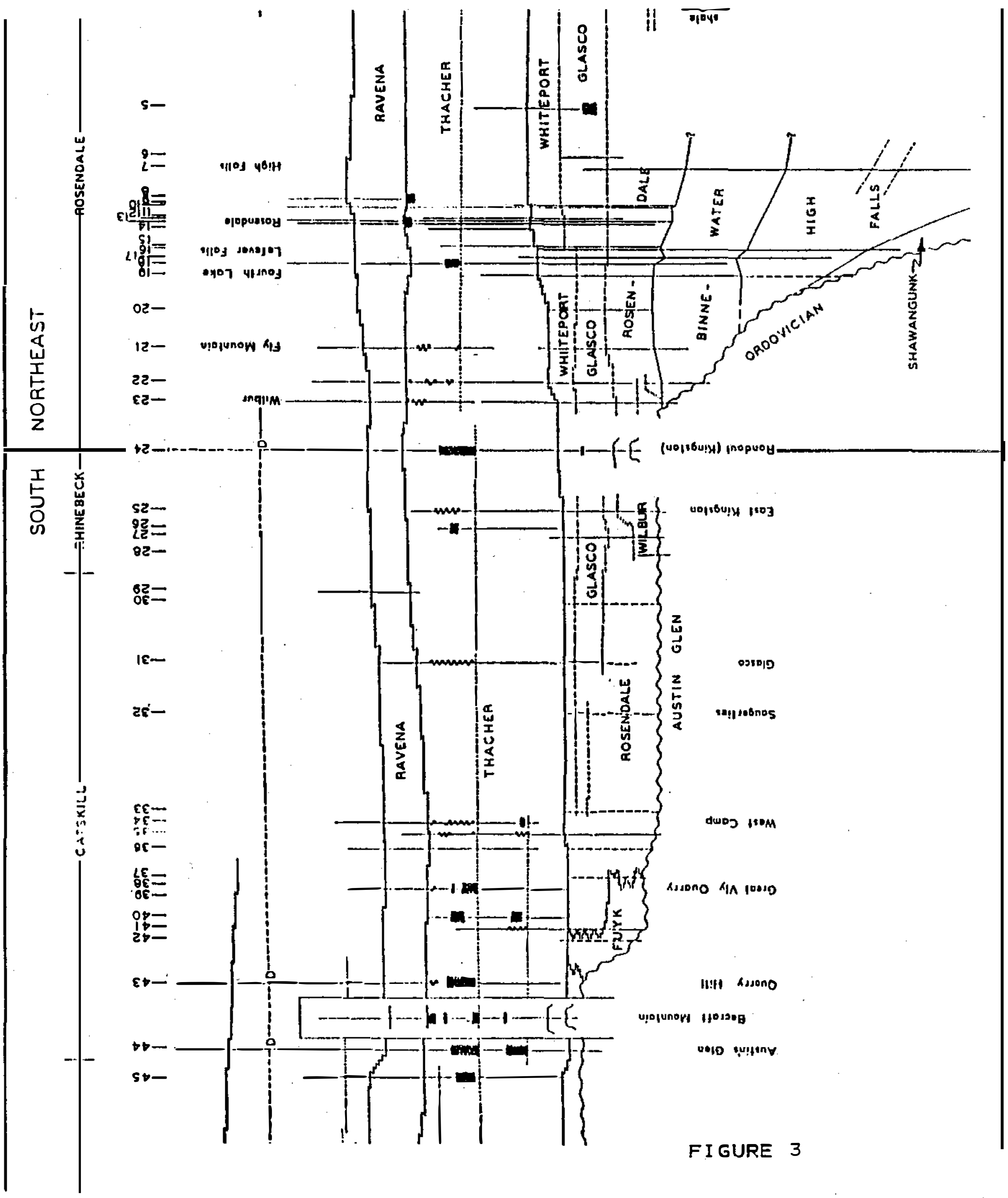


FIGURE 3

presented in the text of this paper and Figure 2). An increase in the number of Rondout PACs at Kingston relative to Catskill indicates progressive stepwise onlap to the north over the Ordovician land surface during Rondout time (Fig.4).

STOP 6. SOUTH WILBUR Abandoned quarry above road along Rondout Creek, .5 miles southwest of Wilbur, New York.

Exposed at this locality are two PACs of the Binnewater Sandstone (Fig. 5, taken from Buggey, 1984), four Rondout PACs and eight Manlius PACs (Fig. 2). Several observations and interpretations can be made at this locality. 1. There is an excellent correlation of PACs in the Manlius interval with those observed at Kingston localities A and B. Key correlation points include the major facies change to calcarenite at the base of PAC 7, the thin-bedded gastropod bearing facies which characterizes PACs 9 and 10 and the major facies change to thick-bedded stromatoporoid bearing calcarenite at the base of PAC 11.
2. More erosion at the Manlius-Coeymans cryptic unconformity has reduced the thickness of PAC 12 to about 1 meter. Note the minor paleokarst developed on the unconformable surface. 3. PAC 4 appears between PACs 3 and 5 (Fig. 2). The presence of this PAC to the south and its absence to the north is evidence of a minor cryptic unconformity. In the initial study of this interval Osborn (1983) recognized the facies change which now defines the boundary at the base of PAC 4 but did not set it off as a PAC boundary because it was absent at the northern localities (Fig. 4). Osborn placed this unit in the upper 2-4 feet of the Whiteport Member of the Rondout Formation at the Fourth Lake, Wilbur and Connelly localities. Interpretation of a cryptic unconformity at this level provides an explanation for these facies patterns. 4. The two Binnewater PACs preserved at this locality were shown by Buggey (1984) to be correlated with two PACs in the middle of the Binnewater Formation ten miles to the south at High Falls (Figs. 6 and 7). This correlation leads to the interpretation of the Binnewater-Rondout contact as a cryptic unconformity at which at least two PACs are lost at South Wilbur (Fig. 6). 5. Finally the High Falls and Binnewater Formations progressively and episodically onlap the underlying Ordovician Normanskill Formation as does the Rondout Formation at Kingston and to the north (Figs. 4 and 6).

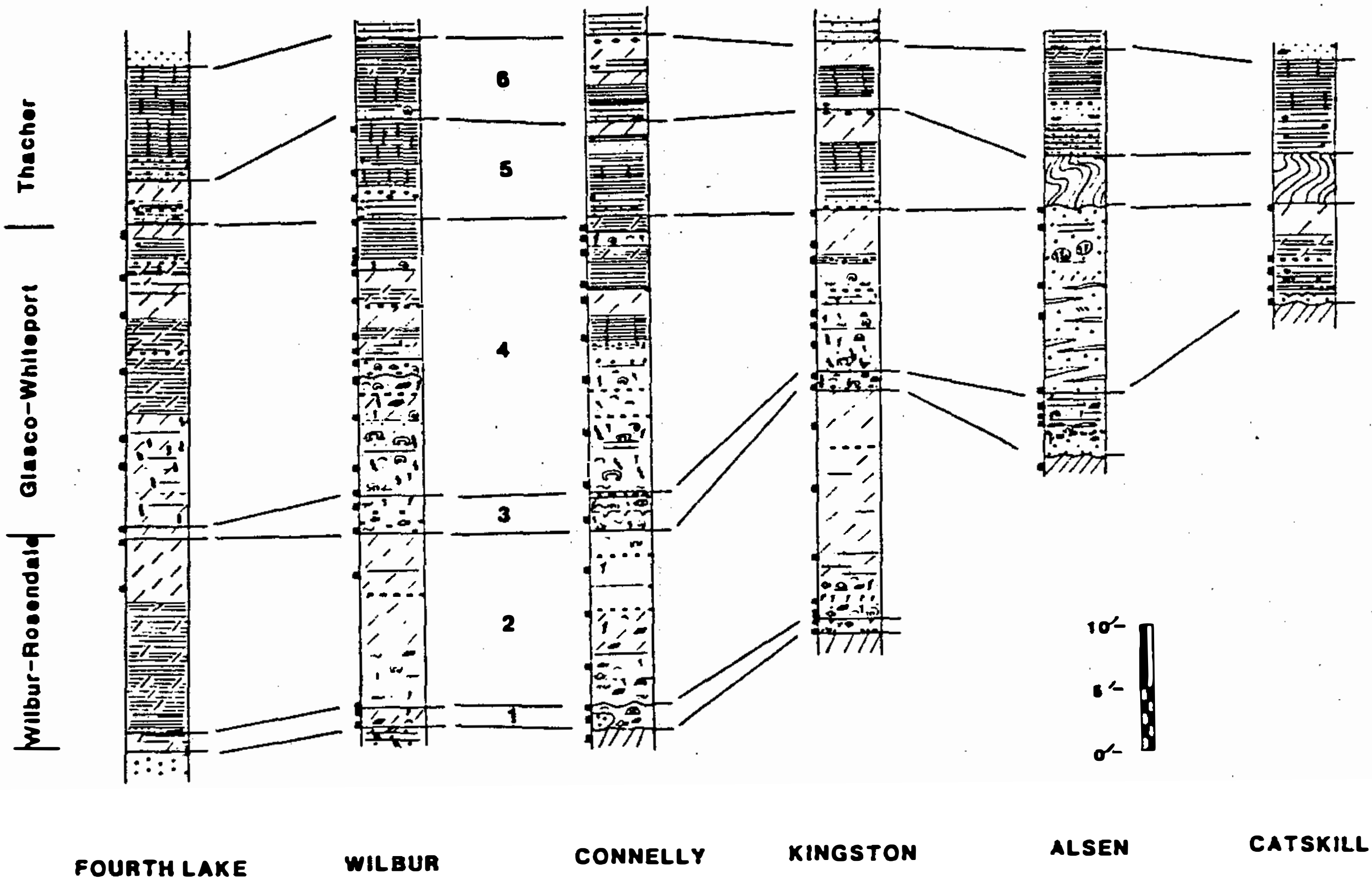
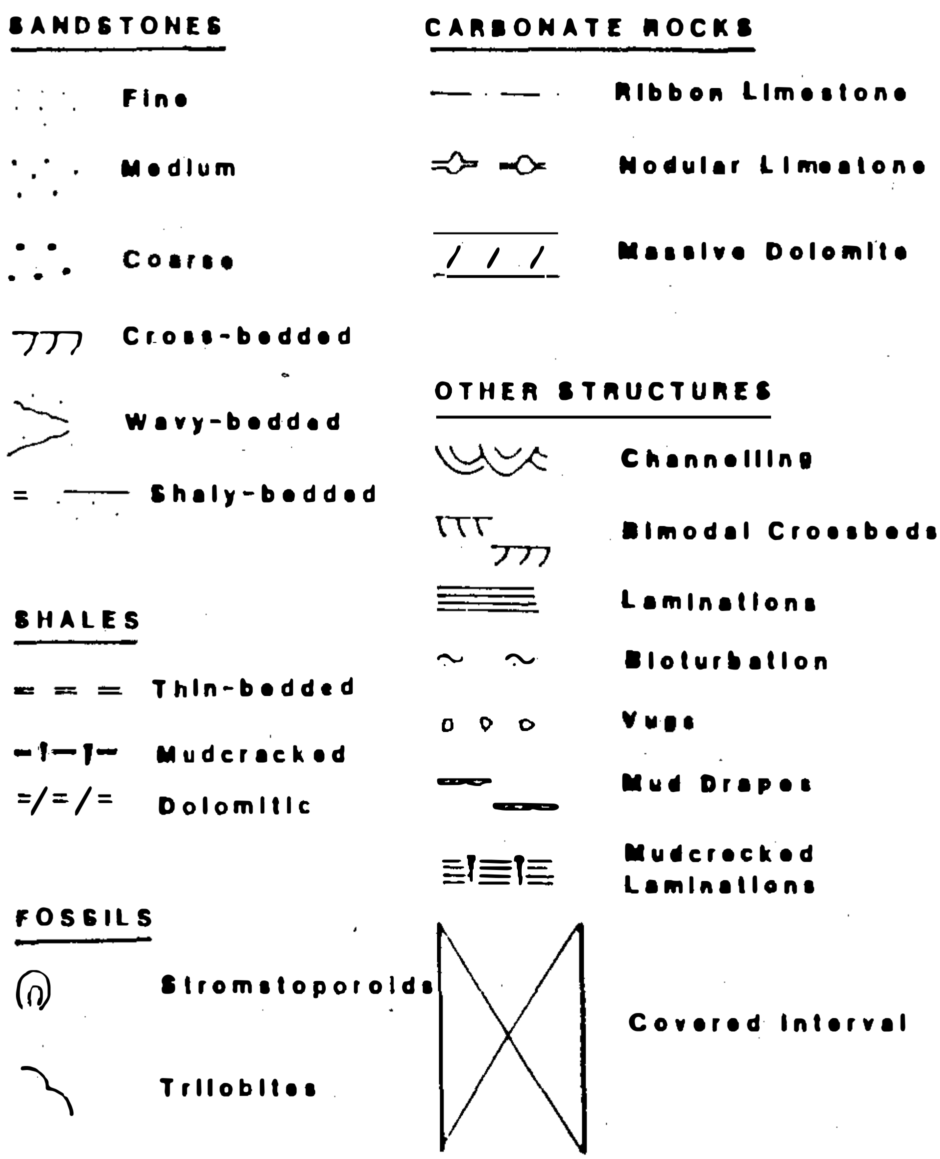


Figure 4. PAC correlations, Rondout Formation, Hudson Valley, New York (from Osborn, 1983)



Legend for figures 5 and 7.

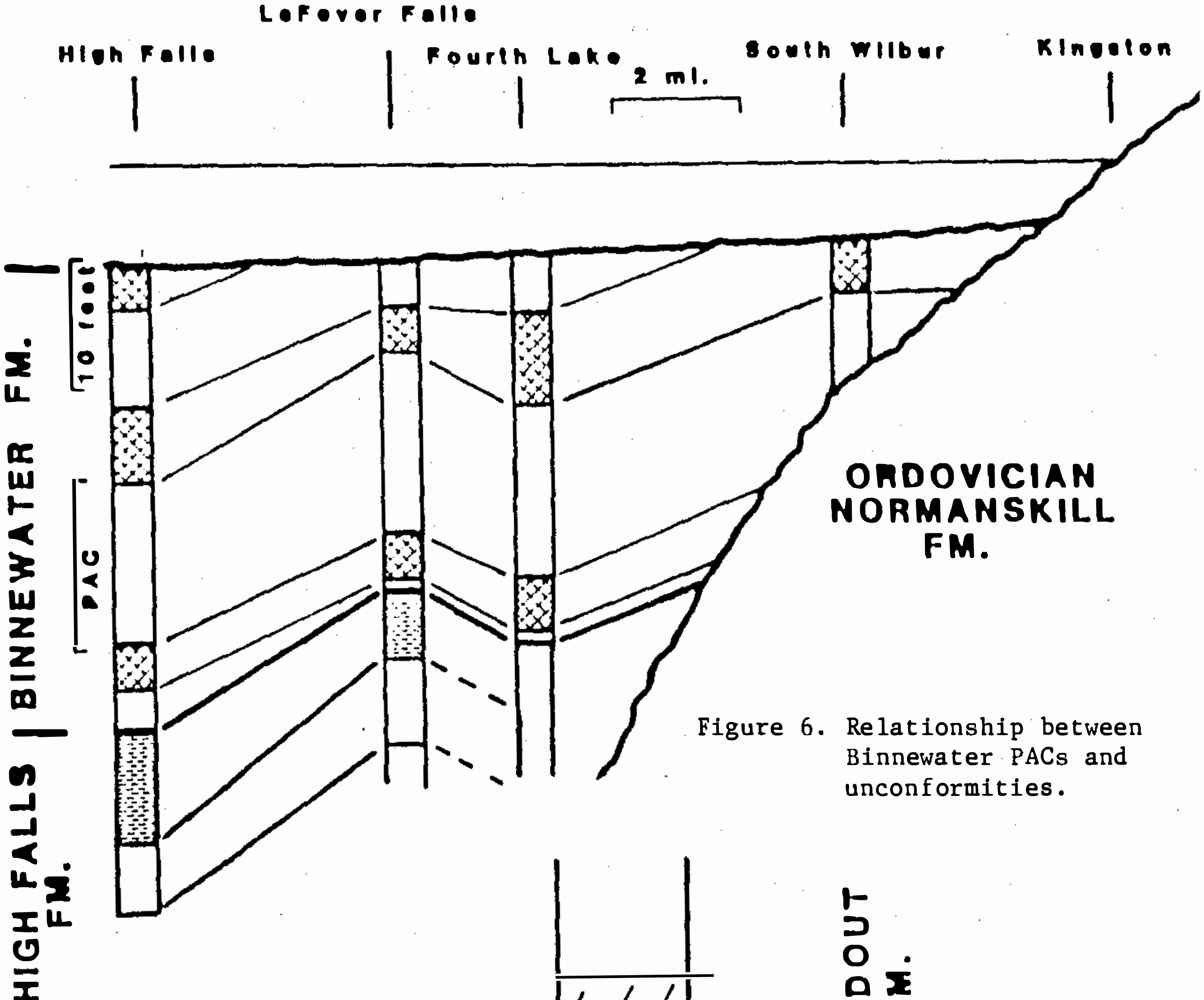


Figure 6. Relationship between Binnewater PACs and unconformities.

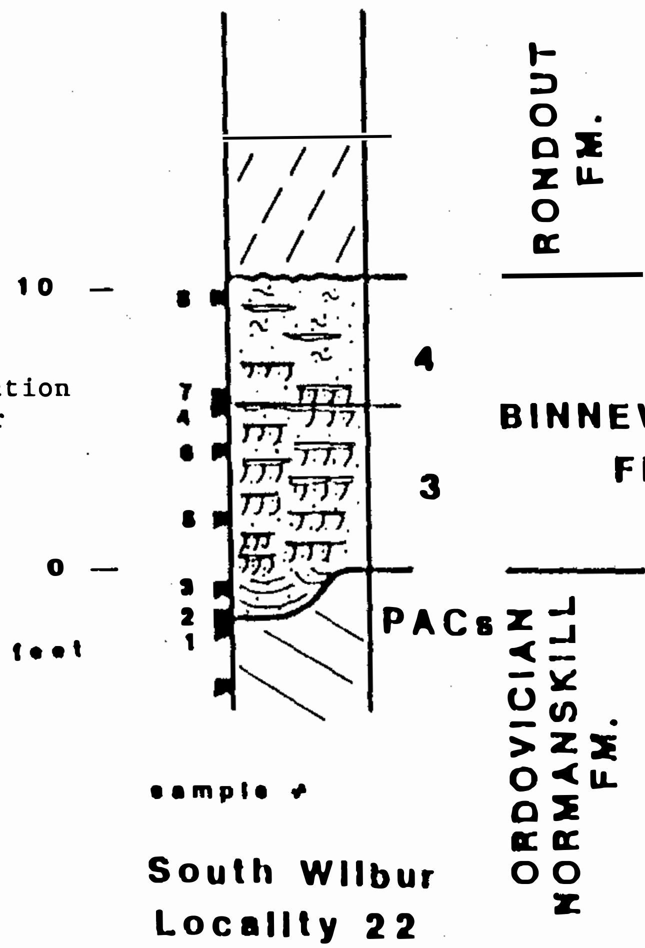


Figure 5. Columnar section South Wilbur locality.

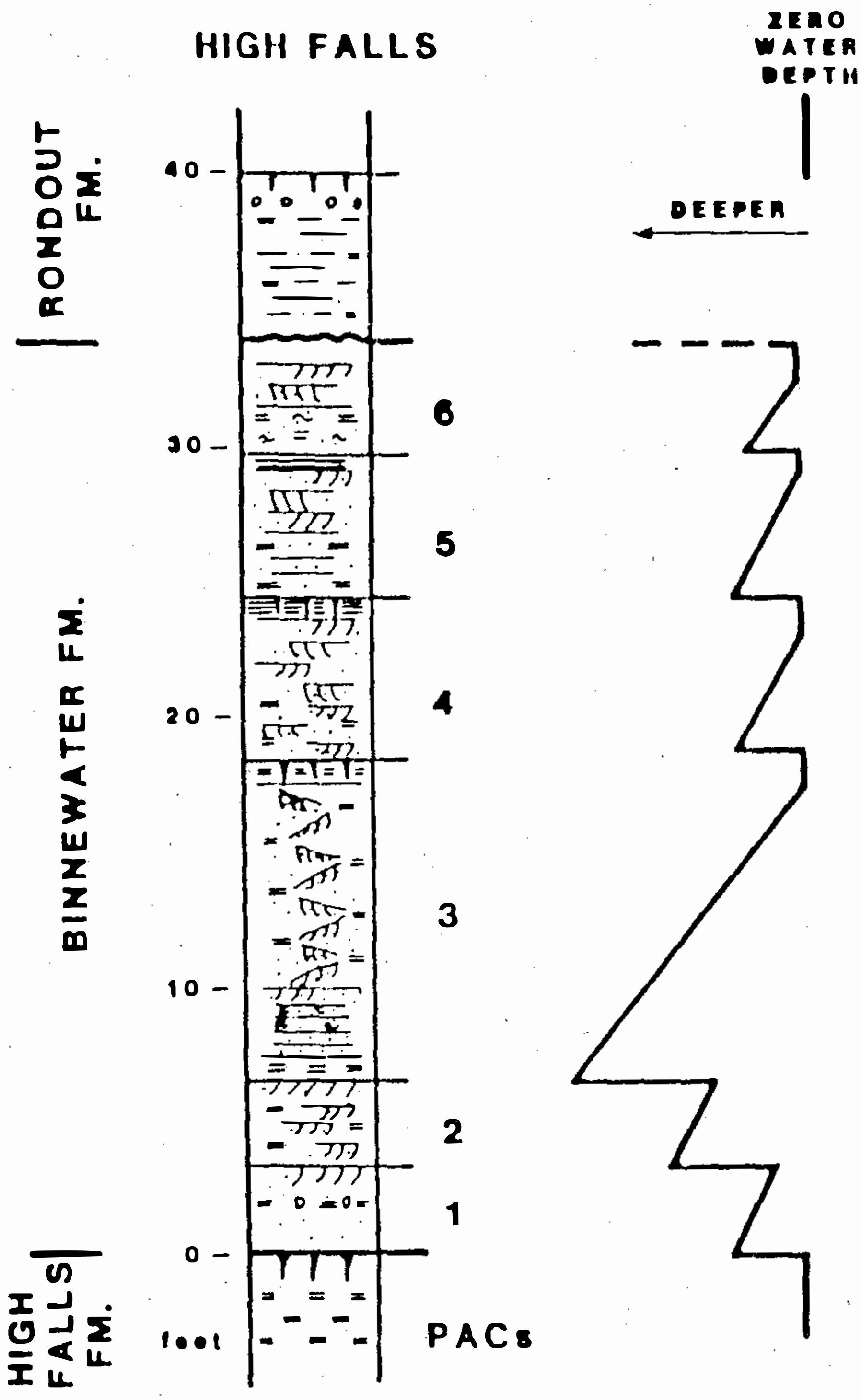


Figure 7. Columnar section, High Falls locality.

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