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Hydrogeology • Mineral Resources Waste Management • Geological Engineering • Mine Hydrology

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February 13. 1986
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WM DOCKET CONTROL CENTER

Mr. Jeff Pohle
Division of Waste Management
Mail Stop 623-SS
U.S. Nuclear Regulatory Commission
Washington. D.C. 20555

RE: BWIP

Dear Jeff:

We have reviewed the hydraulic head data for BWIP. The data we have available for review begin in April 1984 and extend through April 1985. The barometric effects have been removed from the set of data we reviewed. Copies of the water level graphs which we prepared under the previous contract on BWIP are attached to this letter; these graphs were sent to the NRC as Communication No. 142. Unfortunately, the hydraulic head data that we saw during the December 1985 workshop held in Richland, Washington, are not available for our review. The hydrographs that were distributed at the meeting indicate that a significant perturbation to the hydrologic system occurred at BWIP due to the drilling of the new well DC-23W and the pulling of the bridge plug in RRL-14. Obviously our comments are restricted to the water level data from April 1984 through April 1985.

We have prepared a table of hydraulic gradients which we derived from three-point diagrams constructed from the water level data. We selected points in time from the record for which to establish the direction of groundwater flow and the approximate hydraulic gradient. The attached table presents the calculated gradients and directions of groundwater flow for the Priest Rapid, Sentinel Gap, Ginkgo, Rocky Coulee, Cohassett, and Umtanum flows. As you can see, the directions of groundwater flow are dominantly toward the southwest. The directions of flow do not vary more than 20 degrees among any of the flow tops that are being monitored. The gradients that we have calculated for the flow tops are all less than two feet per mile for the last three months for which we did the calculations. The gradients calculated in the Wanapum basalt are less than one foot per mile; the gradients range from 0.59

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feet per mile (1.1×10^{-4} ft/ft) to 0.89 feet per mile (1.7×10^{-4} ft/ft). The gradients calculated for the flow tops in the Grande Ronde basalt range from 1 feet per mile (1.9×10^{-4} ft/ft) to 2 feet per mile (4.0×10^{-4} ft/ft).

The three-point diagrams show that the cluster well at DC-20 dominates the determination of flow direction. The equipotential line for hydraulic head approximately runs through boreholes DC-22 and DC-19. For this reason the direction of flow and gradient are dominated by DC-20.

The Cohassett piezometer in DC-20 probably does not contain Hanford system water throughout its entire depth. The crimp in the piezometer (caused by an installation accident) may have precluded replacing the formation water in the piezometer with Hanford system water as was done at the other cluster sites (DC-19 and DC-22). The lower portion of the piezometer probably contains Cohassett flow top water or a mixture of Cohassett flow top water and Hanford system water. The higher density (TDS loading) water in the lower portion of the piezometer will cause surface measurements of water level to be lower than corresponding measurements in other piezometers. This density induced "error" will affect the determination of gradient and direction of groundwater flow in the Cohassett flow top. The attached table of horizontal gradients illustrates that the direction of flow in the Cohassett flow top is about 10 degrees more toward the south than the underlying and overlying flow tops in the Grande Ronde. The gradients in the Cohassett are lower than the gradients in the underlying and overlying Grande Ronde flow tops. The calculation of vertical gradients will be affected with respect to the Cohassett flow top.

The Umtanum flow top in the DC-19 cluster contains Umtanum flow top water rather than Hanford system water. This piezometer contains Umtanum flow top water because this piezometer was air-lift pumped for thermal testing of the other piezometers in the same cluster. The higher density water in this piezometer will produce lower water levels measured at the surface in this piezometer. Gradients and flow directions are affected in the Umtanum flow top; the degree to which gradient and flow direction are affected is unknown. The calculation of vertical gradient, with respect to the Umtanum flow top, will be affected.

We have used the difference in hydraulic heads between flow tops in conjunction with the distance between the mid-point of the screen intervals in these cluster wells to determine the vertical gradient at each cluster. We assume that the screens were placed at the mid-point of the producing zone of the flow top being monitored. We cannot verify our approach via reference to a Rockwell document at this time. We believe that this procedure is sufficiently accurate for the determination of vertical gradients. It should be kept in mind that the vertical gradients are represented by environmental heads that reflect the effects of temperature but not of total dissolved solids content of formation water. A table of vertical gradients is attached to this letter.

The table of vertical hydraulic gradients and groundwater flow directions illustrate two main points. First, the flow directions are almost uniformly upward. An inconsistency in the flow occurs at the DC-19C site; the hydraulic head is higher in the Rocky Coulee flow top than in the Cohassett flow top. We do not have an explanation for this apparent reversal in flow direction. We will address the apparent flow directions and gradients in our letter report on conceptual flow models for the BWIP site. The second point is that the vertical gradients are in general an order of magnitude higher than the horizontal gradients. The relationship between the head in the monitored flow tops must be viewed with caution. These monitored flow tops are not located adjacent to each other; there are intervening flow tops that are not monitored.

We have reviewed the hydrogeologic data noted earlier in our letter. We recommend that two additional monitoring wells are required to validate the determination of groundwater flow direction and gradient. As we noted, borehole cluster DC-20 dominates the determination of flow direction from the point of view of a three-point analysis. This domination is not a consequence of the procedures but rather a consequence of the fact that only three observation points are available for which we have confidence in the hydraulic head measurements. We believe that observation wells to the southwest and northeast of this three-point cluster would help validate the direction of groundwater flow.

We would like to emphasize that the horizontal gradients are at a much lower magnitude than the vertical gradients monitored in the boreholes. The vertical gradient appears to dominate the hydrogeologic system. We are still evaluating our concerns regarding this apparent hydrogeologic phenomenon with respect to conceptual groundwater flow models for the BWIP site. The very low horizontal gradients raise questions about possible errors that might have occurred without detection. An error band exists with respect to the interpretation of hydraulic head and pressure data. We believe that the error band may be significant in the context of the low hydraulic gradients derived in our analysis. We cannot identify any significant in-well error associated with the measurement of hydraulic heads. We do believe that minor errors between wells may constitute a significant portion of an error band with respect to the magnitude of the gradient. Quite franklv a relatively large error band combined with verv low gradients but reasonably consistent gradient directions among flow tops is somewhat perplexing.

We suggest that an attempt be made to conduct some elementary modeling of a vertical cross section running from DC-20 perpendicular to the equipotential line determined from a three-point analysis of heads. This vertical section could be used to model inversely an approximate vertical hydraulic conductivity between the flow tops which are being monitored at this time. We believe this effort should be a preliminary estimate for assistance in evaluating the future large-scale hydraulic stress test which is planned for the BWIP site.

Please call if you have any questions regarding our review. We will contact you should we have any further revelations regarding the hydraulic head data that we have reviewed for this letter. In addition, we will provide additional comments regarding our evaluation if and when the aforementioned additional head data become available.

Sincerely,

Gerry Winter

Gerry V. Winter

GVW:sl

Horizontal Gradient

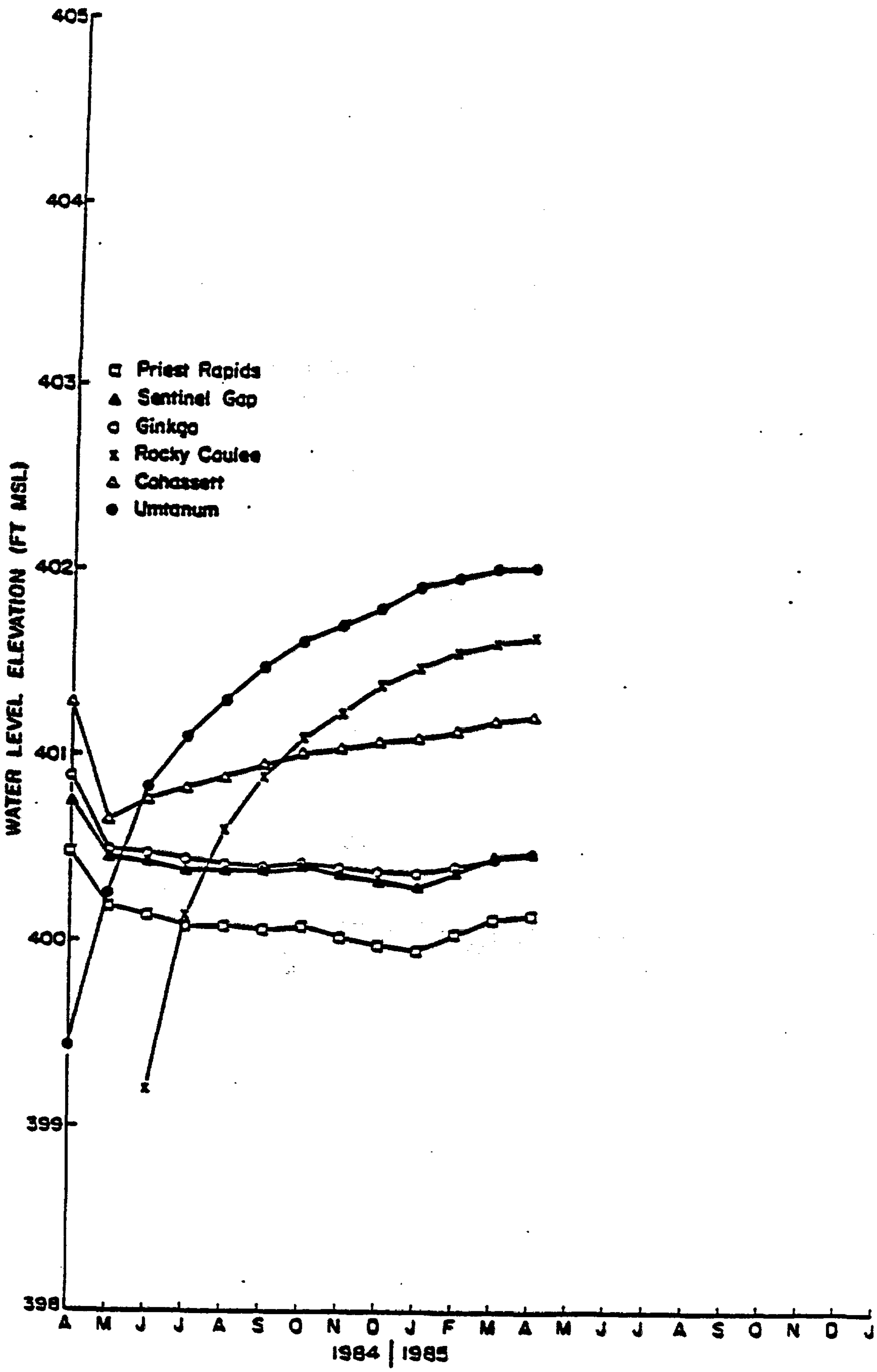
Date	Gradient ft/mile	Gradient ft/ft	Bearing
Priest Rapids			
8/31/84	0.86	1.6×10^{-4}	S45°W
2/28/85	0.87	1.7×10^{-4}	S42°W
3/31/85	0.86	1.6×10^{-4}	S42°W
4/30/85	0.89	1.7×10^{-4}	S42°W
Sentinel Gap			
8/31/84	0.75	1.4×10^{-4}	S44°W
2/28/85	0.75	1.4×10^{-4}	S43°W
3/31/85	0.73	1.4×10^{-4}	S43°W
4/30/85	0.72	1.4×10^{-4}	S43°W
Gingko			
8/31/84	0.69	1.3×10^{-4}	S41°W
2/28/85	0.62	1.2×10^{-4}	S38°W
3/31/85	0.59	1.1×10^{-4}	S37°W
4/30/85	0.62	1.2×10^{-4}	S38°W
Rocky Coulee			
8/31/84	2.1	4.0×10^{-4}	S48°W
2/28/85	1.2	2.3×10^{-4}	S38°W
3/31/85	1.3	2.5×10^{-4}	S33°W
4/30/85	1.2	2.3×10^{-4}	S34°W
Cohassett *			
8/31/84	1.1	2.1×10^{-4}	S32°W
2/28/85	1.0	1.9×10^{-4}	S21°W
3/31/85	1.1	2.1×10^{-9}	S22°W
4/30/85	1.1	2.1×10^{-9}	S21°W
Umtanum **			
8/31/84	1.2	2.3×10^{-4}	S33°W
2/28/85	1.3	2.5×10^{-4}	S32°W
3/31/85	1.4	2.7×10^{-4}	S32°W
4/30/85	1.3	2.5×10^{-4}	S32°W

* The measured water level in Dc-20 is probably lower than if the piezometer contained Hanford system water for its entire depth; there is reason to doubt that this piezometer contains Hanford system water for its entire depth

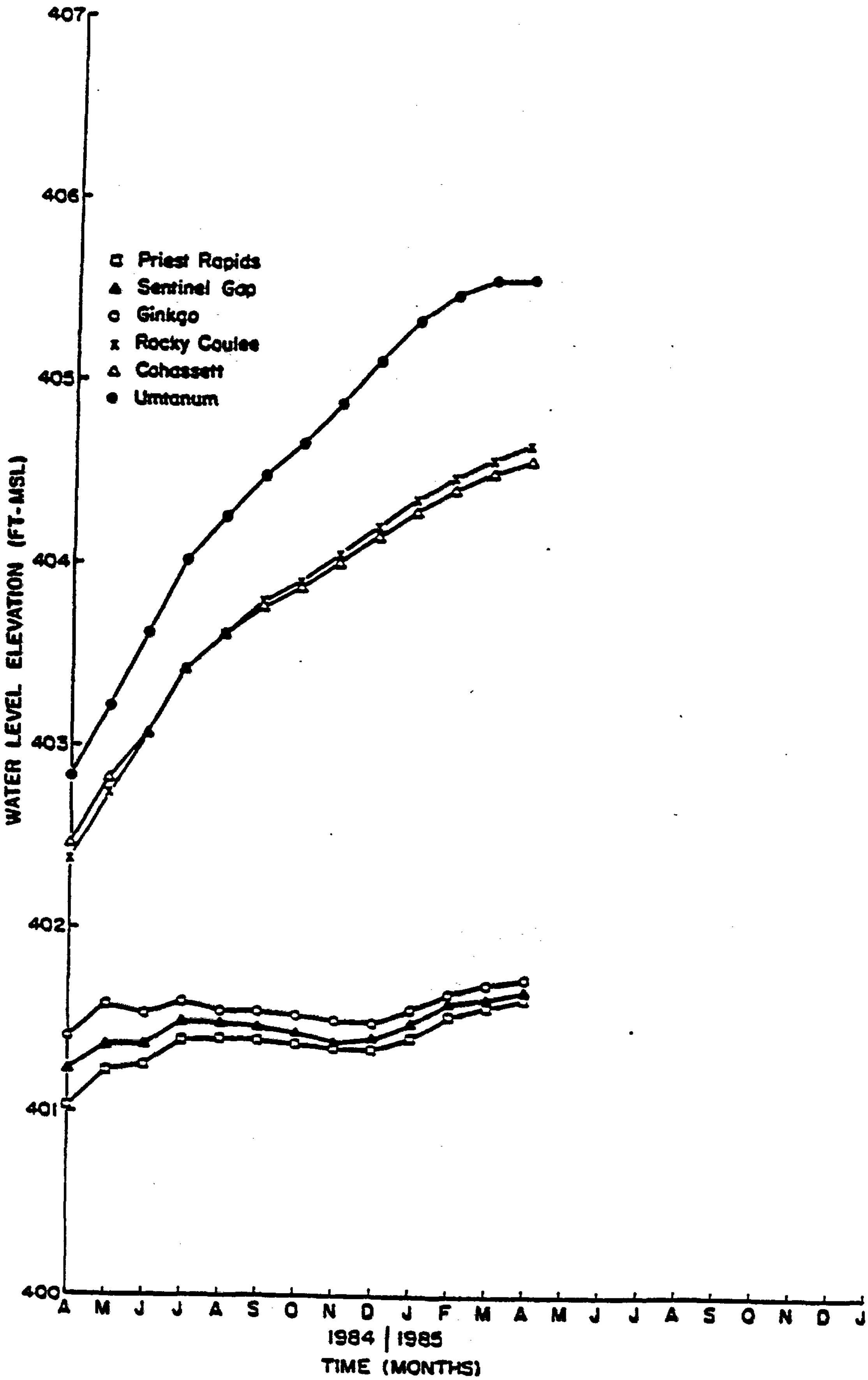
** The Umtanum piezometer at DC-19 does not contain Hanford system water as do the other Umtanum piezometers: measured water levels in DC-19 are probably lower than if the piezometer contains Hanford system water.

Vertical Gradients

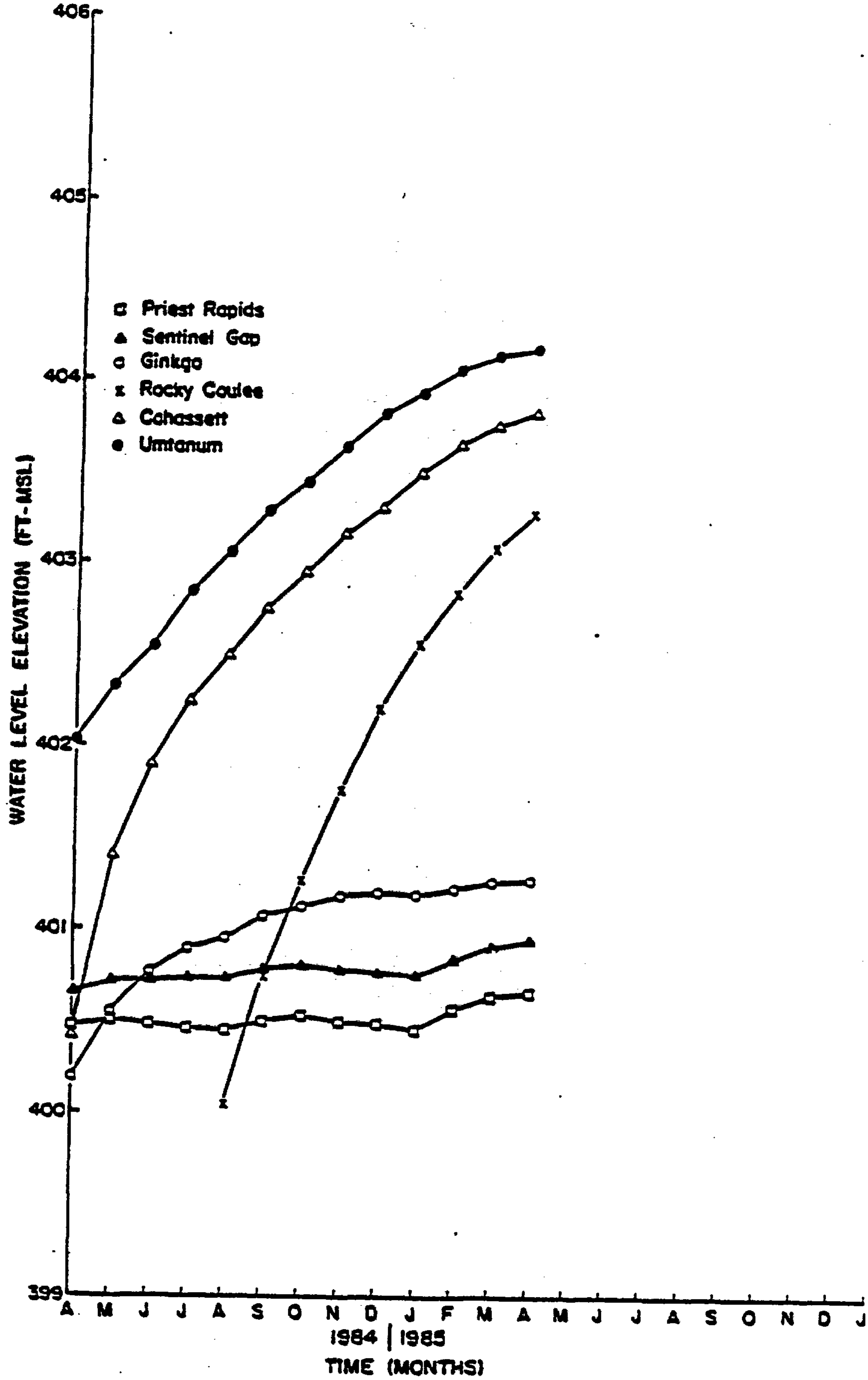
	Gradient ft/ft
Borehole DC-19c	
Priest Rapids/Sentinel Gap	2.0×10^{-3} ↑
Sentinel Gap/Gingko	3.8×10^{-4} ↑
Gingko/Rocky Coulee	3.5×10^{-3} ↑
Rocky Coulee/Cohassett	1.3×10^{-3} ↓
Cohassett/Umtanum	1.7×10^{-3} ↑
Borehole DC-20c	
Priest Rapids/Sentinel Gap	7.0×10^{-4} ↑
Sentinel Gap/Gingko	4.0×10^{-4} ↑
Gingko/Rocky Coulee	9.3×10^{-3} ↑
Rocky Coulee/Cohassett	9.7×10^{-4} ↑
Cohassett/Umtanum	1.9×10^{-3} ↑
Borehole DC-22c	
Priest Rapids/Sentinel Gap	2.0×10^{-3} ↑
Sentinel Gap/Gingko	8.0×10^{-4} ↑
Gingko/Rocky Coulee	7.4×10^{-3} ↑
Rocky Coulee/Cohassett	4.0×10^{-3} ↑
Cohassett/Umtanum	7.6×10^{-4} ↑



MEAN MONTHLY WATER LEVELS CORRECTED FOR BAROMETRIC EFFECT-
DC-19C



MEAN MONTHLY WATER LEVELS CORRECTED FOR BAROMETRIC EFFECT-
DC-20C



MEAN MONTHLY WATER LEVELS CORRECTED FOR BAROMETRIC EFFECT–
DC-22C