CALIFORNIA WELL SAMPLE REPOSITORY

Special Publication No. 2

Display of Cores From
The Winters Sand (Upper Cretaceous)
Sacramento Valley, California

May 7-12, 1979

Cal State Bakersfield
9001 Stockdale Hwy 93309

$2.00

TABLE OF CONTENTS

INTRODUCTION

In May 1978, the California Well Sample Repository inaugurated what it anticipates will become at least an annual event: an "Open House" type of display of cores and samples of significant interest to California geologists and engineers. The first Open House, a collection of cores from the Stevens Sand (upper Miocene, San Joaquin Valley) was attended by almost 200 geologists from California, Colorado, Oklahoma, and Texas. This year the display will be of cores from the Winters sand, an important gas-producing reservoir of the Upper Cretaceous of the Sacramento Valley. Although far fewer cores have been taken in the Winters than the Stevens, we believe that a sufficient number are available for inspection and study to materially aid any interested worker in understanding the nature of deposition of this sand.

The Winters was first found productive by Shell Oil Co. in its "McCune" No. 1, Sec. 29, T. 8N, R. 1E, in 1946. Because of the proximity of the well to the nearby town of Winters, both the field and the previously unknown sand have been called "Winters." Since then sands within this zone have been found productive in more than 20 fields (as designated by the Division of Oil and Gas), in a variety of structural and/or stratigraphic traps. It has been, and continues to be, one of the more attractive objectives for prospecting in the Sacramento Valley.

On display at this year's Open House are cores and samples from the Winters, Todhunters Lake, and Union Island Gas Fields, the Cities Service "Nixon Community" 1 wildcat well, and the sub-Winters shales of the Putah Creek outcrop section.

By far, the largest Winters sand gas field, and indeed one of the largest fields in the Sacramento Valley, is Union Island, discovered by Union Oil Co. in 1972. We are particularly fortunate to be able to have on display cores from four of the wells from this field, and doubly fortunate to have the excellent summary, with map, sections, and portions of electric logs, by D. R. Hill, included in this publication. This brief report, the first geological information published on this field, covers the salient features which Hill described and discussed in his excellent presentation of the Union Island Gas Field at the Pacific Section meeting of the AAPG at Sacramento in April 1978. For your additional reference and study we have included some photographs of portions of these cores.

We are also very pleased to have in our publication a most interesting discussion of the Winters sand and its geological development by Susan Hughes, Cities Service Co., Denver; and a summary of the Upper Cretaceous stratigraphy of the Putah Creek Section by Edwin H. Stinemeyer, consulting micropaleontologist, Bakersfield.

Obviously it takes a great deal of work and cooperation to be able to make a display such as this successful in the sense for which it is planned: as an aid to explorationists in the oil and gas business. Of the many who have helped, we wish to particularly thank the following: Union Oil Company, Shell Oil Company, Getty Oil Company, and Cities Service Company, for cores; D. R. Hill, Susan Hughes, and Edwin H. Stinemeyer, for their articles in this publication; William Rintoul (Bakersfield Californian) and Averill Munger (Munger Oilograw) for publicity; Jack Tucker, curator of the Well Sample Repository, for preparation and layout of the display; Chuck Bloomquist, Cal State Bakersfield Foundation, for photographs; Marie Covin, secretary to the Dean of Arts and Sciences, Cal State Bakersfield, for many varied services in preparing this publication.

We hope you will find the Winters display interesting, instructive, and helpful, and this publication a thought-provoking and a continuing source of information. We shall welcome any suggestions you wish to make for improving future similar events.

H. Victor Church
Project Director
California Well Sample Repository

WINTERS SAND

Susan M. Hughes
Cities Service Company
Denver, Colorado

Winters sand is the name given to sand units deposited in the Southern Sacramento Valley in Late Cretaceous (Late Campanian-Early Maestrichtian) time. The Winters is actually a sequence of sand beds, lenses, and channels separated by shale interbeds. The sands contain outer neritic to inner bathyl faunas corresponding to the E through C foraminiferal zones of Goudkoff (1945). According to Drummond et al. (1976), the Winters sands were deposited as a series of sediment gravity flows, in water depths ranging roughly from 300' to 1500'.

The Winters sand is the deep water submarine fan sand member of a time-transgressive lithofacies model deposited simultaneously with the Delta shale foreslope and the Starkey shelf sands, as shown in Figure 1. Development of the three lithofacies occurred in response to variation in water depth and corresponding current energy levels. The Starkey and Winters are lithologically similar, suggesting that the Winters may have been derived from the Starkey, carried by longshore currents into distributary channels and deposited in the elongate north-south trending ancestral Sacramento Basin. Through time, westward progradation of the deltaic system filled the basin, causing the Winters sands to be overlain first by the deltaic foreslope shales and finally the Starkey shelf sands, as shown in Figure 2. From this time on, shallow marine to non-marine deposition prevailed in the Sacramento Basin.

The eastern limit of the Winters sand is shown in Figure 3. The Winters is truncated on the west and north side of the Sacramento Valley by the McCormack and Capay (Margaret Hamilton) unconformities, and for this reason its original depositional extent is unknown. Though poorly exposed, outcrops of the Winters sands occur on the west side of the Sacramento Valley, in Briones Valley on Deer Valley Road in Section 32, T1N-R2E. Here the sands are iron stained, massive and very friable and contain no visible bedding or sedimentary structures.

Examination of sands in Winters cores indicates an abundance of fine to medium, angular to subangular feldspar grains and rock fragments. As shown by a petrographic study of the Winters core in the Cities Service "Nixon Community #1" (Rennison, 1976), rock fragments, mainly sialic and mafic volcanics, dominate the framework composition, making up 26% of the total. Constituting the remaining grains are quartz (20%), orthoclase (12%), plagioclase (12%), biotite (6%), and chert (4%). Authigenic clay, quartz, and feldspar make up the cementing material within the sandstones. Shales within the cores are horizontally bedded and often contain fossil shell debris.

In general, the massive Winters sands lack internal sedimentary structures. In several cores, aligned horizontal shale fragments and mica plates serve as bedding indicators. Burrowing is common in both the sands and shales, but the burrow types are not diagnostic environmental indicators.

The Winters sands are characterized by high porosities, generally within the range of 20%-30%, and permeabilities ranging between 150-950 md. Thus, reservoir parameters for these sands are excellent.

Gas and condensate have been produced from the Winters since the mid-1940's, with the discovery of the Winters Gas Field, a combination structural and stratigraphic trap in T8N, R1E and 1W. Since that time, the Winters has become an increasingly important target. Typical objectives include updip stratigraphic pinchouts (edgelines) of individual sands, sand channels, and sands faulted against shales by both up-to-the-basin and down-to-the-basin faults. The Winter sand has been found productive in more than 20 gas fields, by far the largest of which is Union Island. With the major discovery in late 1978-early 1979 of condensate and gas in the Winters sands in McCulloch's "Hastings Ranch" 1-22, 2-21, and 2-23, north of Lindsey Slough, the Winters promises to be an even more important objective in future years.

References:

Almgren et al., 1967, Correlation Section #16, Pacific Section AAPG.

Drummond, K. F., Christensen, E. W., and Berry , K. D., 1976, Upper Cretaceous Lithofacies Model, Sacramento Valley, California, AAPG Pacific Section Miscellaneous Publication No. 24, p. 76-88.

Goudkoff, P. O., 1945, Stratigraphic relations of Upper Cretaceous in Great Valley, California, AAPG Bull., Vol. 29, No. 7, p. 956-1007.

Rennison, J., 1976, Field Guide to Stratigraphy, Structure, and Deepwater Sedimentology of Central Northern California Subduction Zone, Cities Service Company Geological Contribution #27.

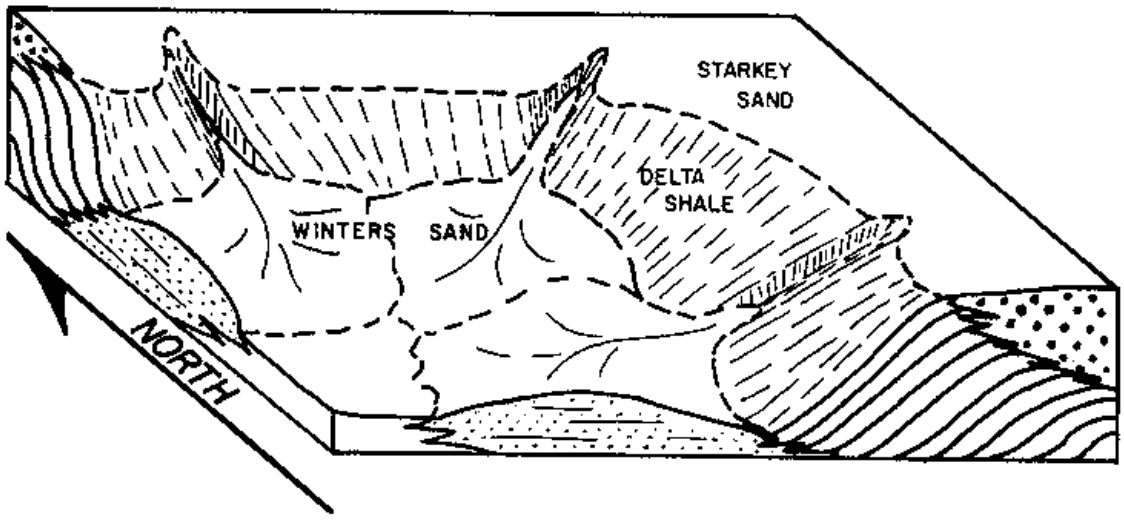
Matthews, J. F., Jr., 1973, California Oil and Gas Fields - North and East Central California, Vol. 1, California Division of Oil and Gas.

Morrison, R. R. et al., 1971, Potential of Sacramento Valley Gas Province, California, in Future Petroleum Provinces of the United States; AAPG Memoir 15 p. 329-338.

Normark, W. R., 1978, Fan Valleys, Channels and Depositional Lobes on Modern Submarine Fans: Characters for Recognition of Sandy Turbidite Environments, AAPG Bull., Vol. 62, No. 6, p. 912-931.

Ziegler, D. L. and Spotts, J. H., 1978, Reservoir and sourcebed history of Great Valley, California, AAPG Bull., Vol. 62, No. 5, p. 813-826.

EARLY STARKEY-WINTERS DEPOSITION



LATE STARKEY-WINTERS DEPOSITION

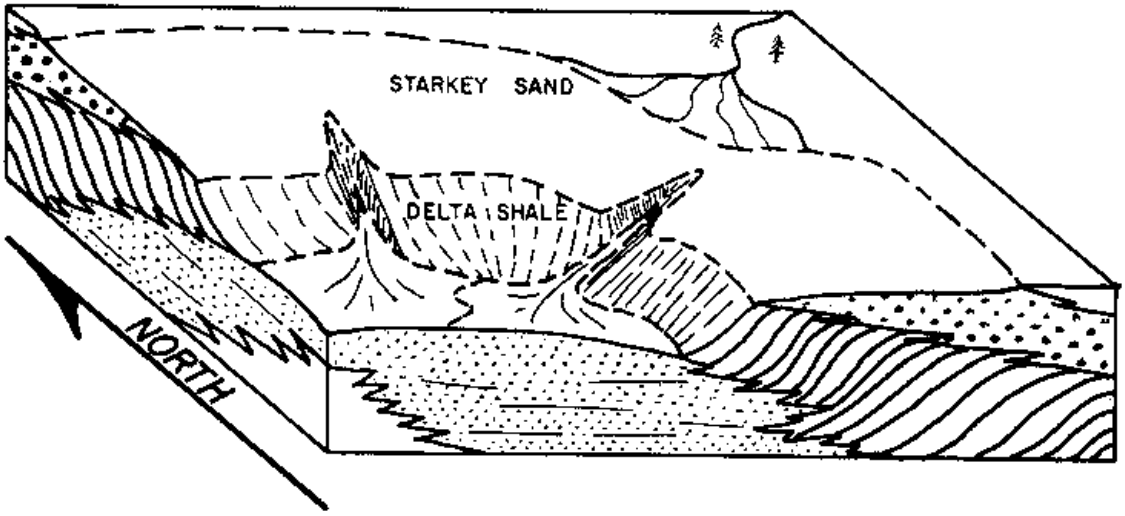


Figure 1—Generalized paleography during Starkey—Winters deposition

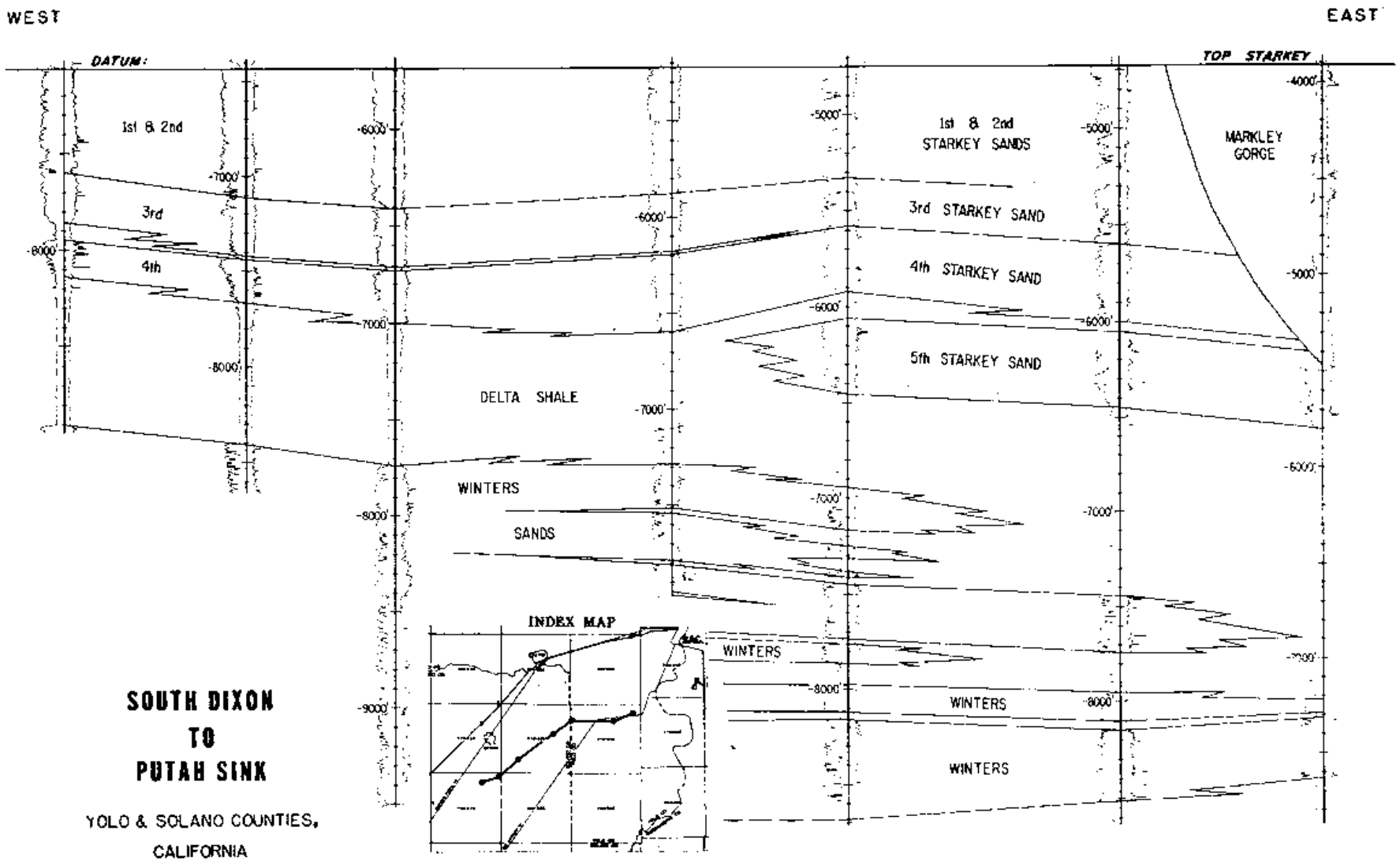


Figure 2—Stratigraphic cross-section from South Dixon to Putah Sink restored to top Starkey datum showing westward progradation of the Delta shale and Starkey sands over sands of the Winters.

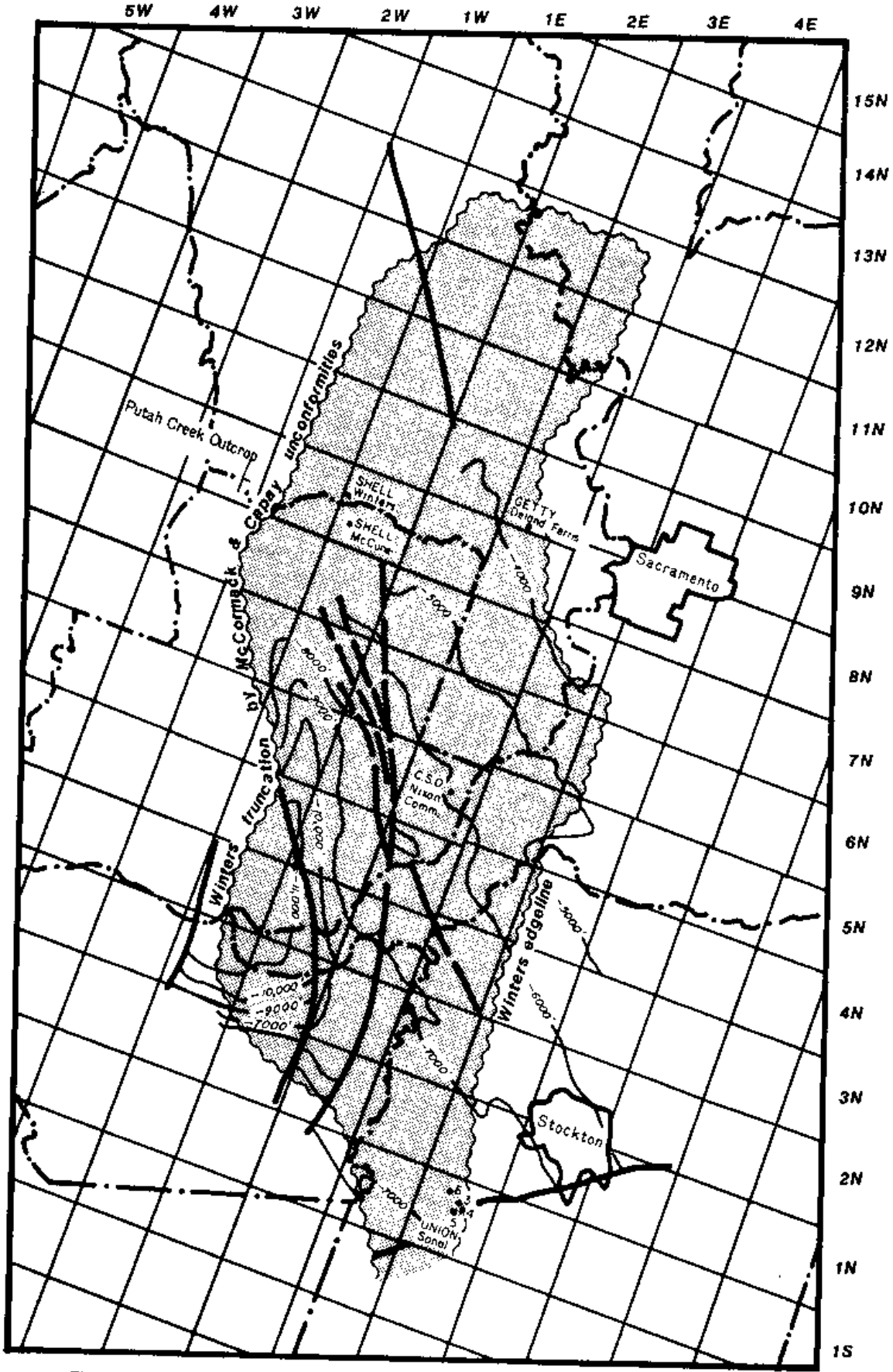


Figure 3 – Eastern edgeline and western truncation of the Winters Sand in the Sacramento Valley. The location of wells, from which the exhibited cores were taken, are also shown. Contours are on top of Starkey Sand. Contour Interval = 1000'.

UNION ISLAND GAS FIELD

San Joaquin County, California
By: D.R. Hill, Exploration Geologist
Union Oil Company of California
Ventura, California

The Union Island Gas Field is located in Northern California approximately 65 miles east of San Francisco (see Figure 1). It lies in an area of significant dry gas production near the Lathrop and McDonald Island gas fields. The field was discovered in early 1972 by Union Oil Company of California when over one hundred feet of net gas sand was penetrated in the discovery well. Since that time, thirteen additional producing wells and three dry holes have been drilled to develop this major gas accumulation in the Upper Cretaceous Winters Sand.

A thick sequence of Upper Cretaceous to Recent age sediments underlies the field area. This 15,000' thick section is composed of interbedded sandstones, siltstones, and shales which were deposited in a wide variety of environments ranging from bathyal marine to nonmarine. Sandstones with good porosity and permeability occur throughout the stratigraphic section.

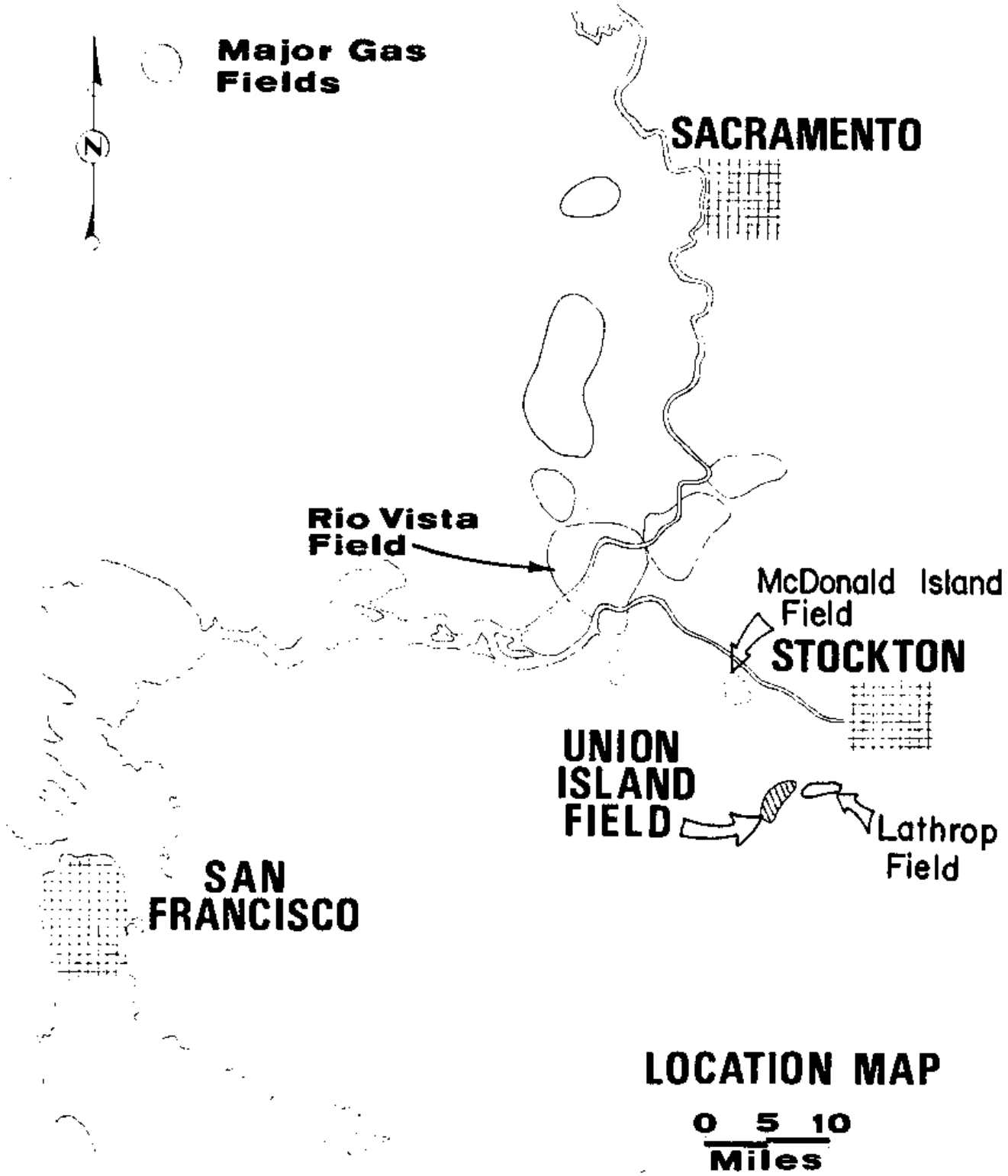
The productive Winters Sand at Union Island Field is part of a thick sequence of deep marine clastics deposited in the southern Sacramento Basin during Late Cretaceous (E-zone) time. The Winters and underlying Lathrop sands were deposited as components of several large submarine fans. In the Union Island Field, a lobe of Winters Sand up to 300' thick extends across the productive area and shales-out to the northeast. This sand body is a complex series of sand-filled channels characterized by rapid lateral and vertical stratigraphic changes. These stratigraphic variations have an important effect on the shape and size of the gas accumulation (see Figure 2 and 8).

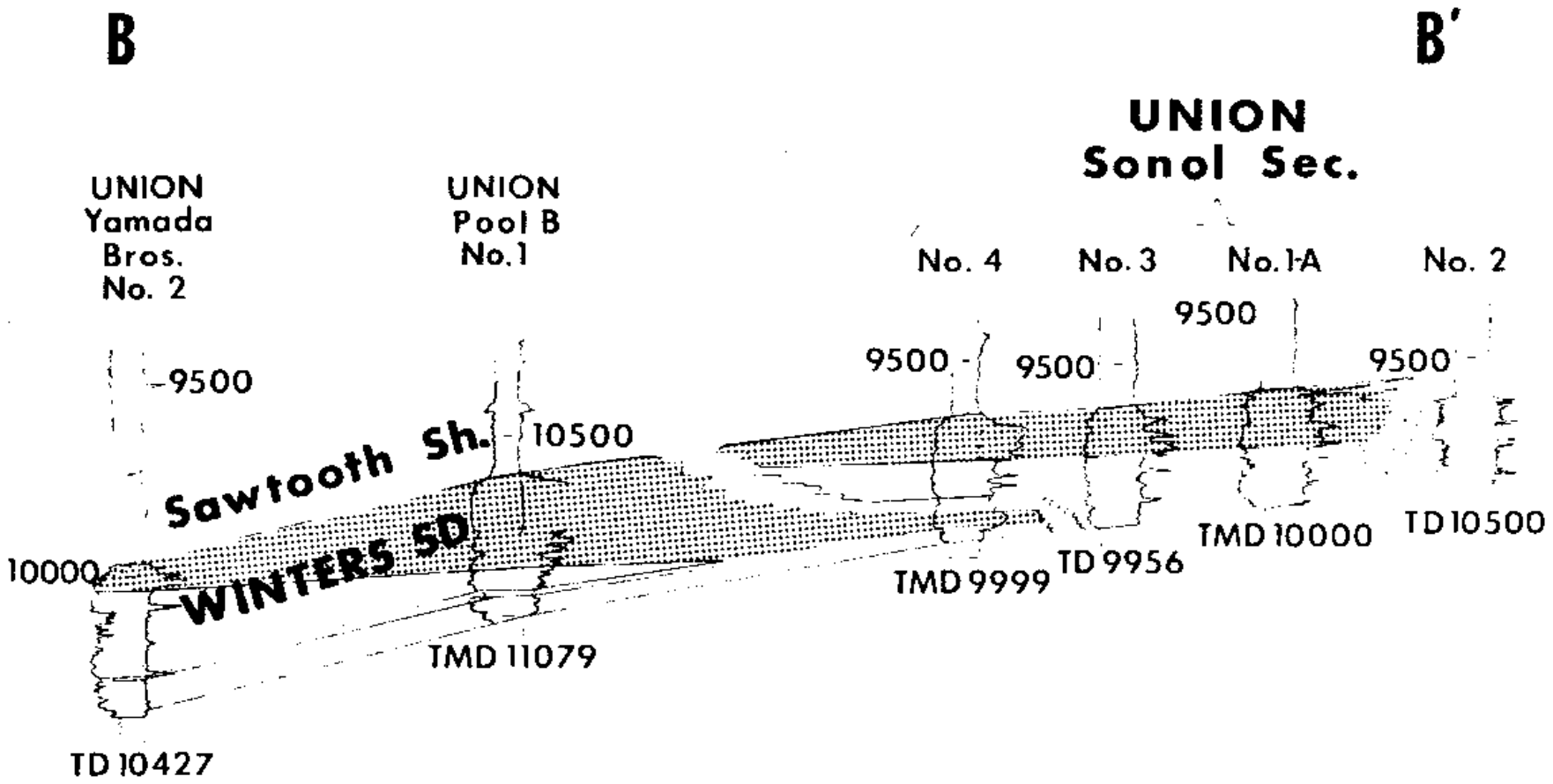
Four wells have been selectively cored in the Winters sand interval (see Figures 3, 4, 5 and 6) in the Union Island Field. The study of these cores, sidewall samples and ditch cuttings has provided much lithologic information concerning the Winters Sand. The productive sands are mostly fine to medium-grained massive sandstones with porosities ranging from 21-29% and measured permeabilities up to 515 millidarcies. These excellent reservoirs are interbedded with gray to dark gray, fine-grained, thin-bedded sandstones, siltstones and shales. The sandstones seldom have graded bedding and have sharp basal contacts with the underlying fine-grained clastics.

The dominant structural feature of the area is the Stockton Arch Fault. This large reverse fault with 900 to 1800' of vertical separation forms the eastern boundary of the field (see Figure 7). A gentle structural bowing against the Stockton Arch fault occurs at Top Winters Sand level in the down-block. However, because of the stratigraphic variations within the Winters, the gas accumulation does not coincide with the structural closure (see Figure 8). The northern closure is provided by shale-out of the upper portion of the sand as well as permeability changes in the sand. Sand stratigraphy has also modified the southern and western margins of the accumulation.

As of January 1, 1979, over 64 billion cubic feet of gas had been produced from the Winters Sand since production began in early 1976. Gas production varies from a high of 110,000 MCF/Day during the winter peak demand period to 4,000 MCF/Day in the summer months. Many of the wells have over 100' of net gas sand and are capable of high production rates. The gas has an average heating value of 890 BTU's and small amounts of 29° gravity condensate are produced. Since gas production began, the original reservoir pressure (5050#) has gradually declined suggesting that an active water drive is not present.

Thus, the discovery of gas at Union Island in early 1972 has had a significant impact on the gas reserves in the Sacramento Valley. It proved that large hydrocarbon accumulations can still be found in well explored basins.


Major Gas Fields
N
SACRAMENTO
Rio Vista Field
McDonald Island Field
STOCKTON
UNION ISLAND FIELD
Lathrop Field
SAN FRANCISCO
LOCATION MAP
0 5 10
Miles



UNION ISLAND FIELD
Strat. Cross Section B-B'
Datum-9500'

Fig. 2

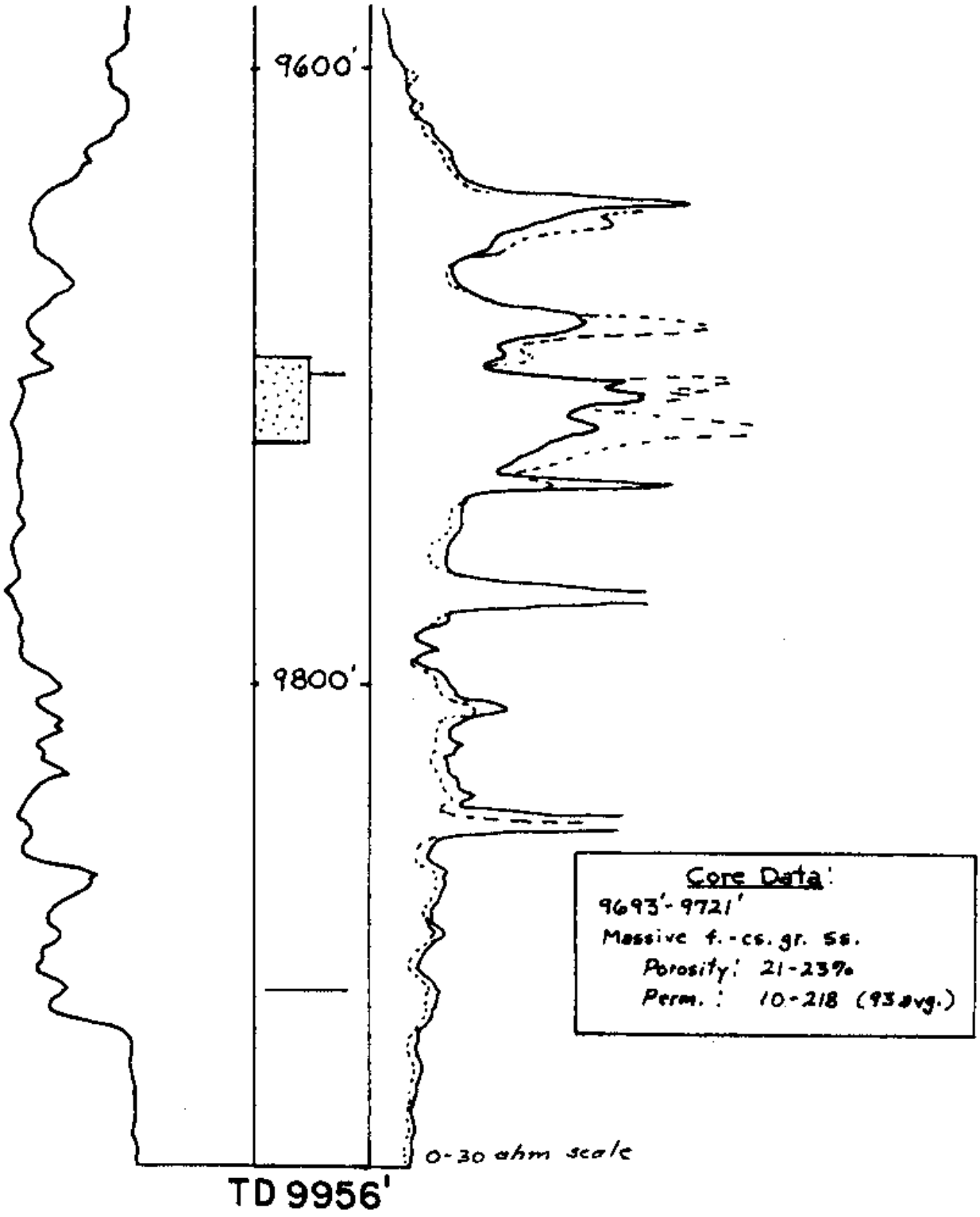

UNION
Sonol Sec. No.3
10-1S/5E
9600'
9800'
Core Data:
9693'-9721'
Massive f.-cs. gr. ss.
Porosity: 21-23%
Perm.: 10-218 (93 avg.)
0-30 ohm scale
TD 9956'

Fig. 3

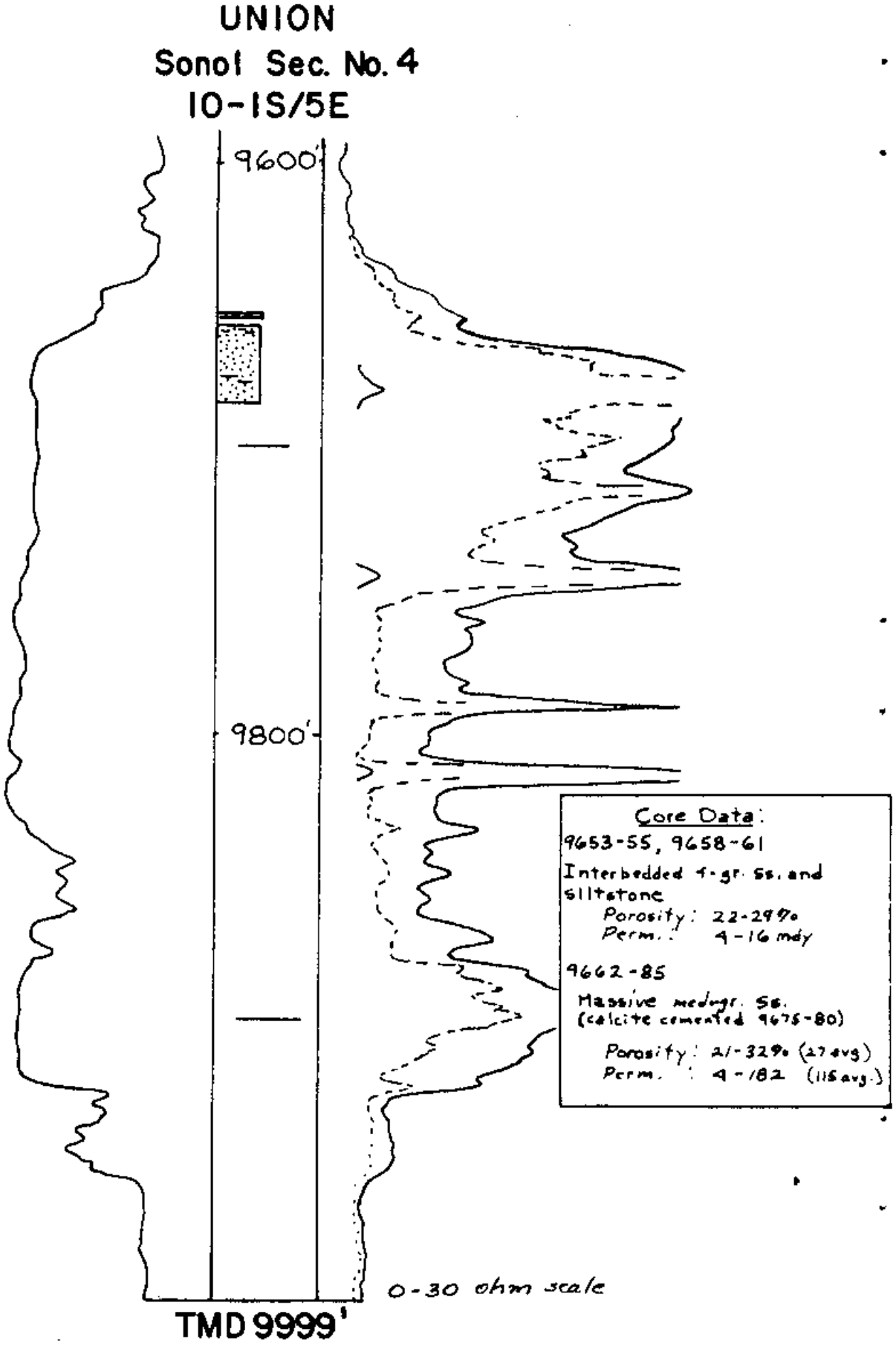
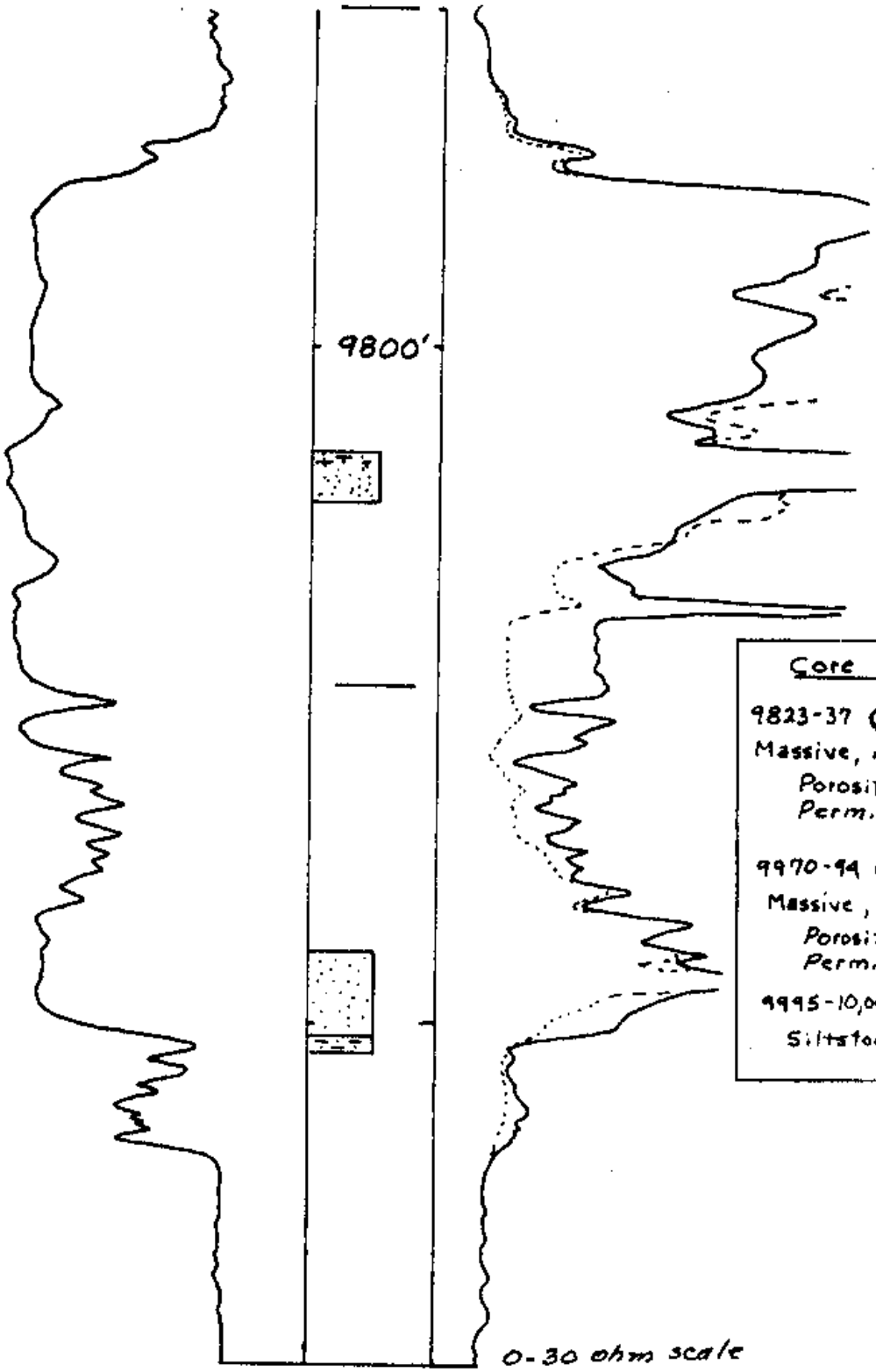

UNION
Sonol Sec. No. 4
10-1S/5E
9600'
9800'
Core Data:
9653-55, 9658-61
Interbedded f-gr. Ss. and siltstone
Porosity: 22-29%
Perm.: 4-16 mdy
9662-85
Massive medgr. Ss.
(calcite cemented 9675-80)
Porosity: 21-32% (27 avg)
Perm.: 4-182 (115 avg.)
0-30 ohm scale
TMD 9999'

Fig. 4

UNION
Sonol Sec. No. 5
15-1S/5E



Core Data:

9823-37 (Log Depth 9832-46)
Massive, med-cs. gr. Ss.
Porosity: 24-26%
Perm.: 275-515 (372 avg.)

9970-94 (Log Depth 9979-03)
Massive, f.-med. gr. Ss.
Porosity: 14-25%
Perm.: 5-130

9995-10,000 (Log Depth 10,004-09)
Siltstone

TD 10,101

Fig. 5

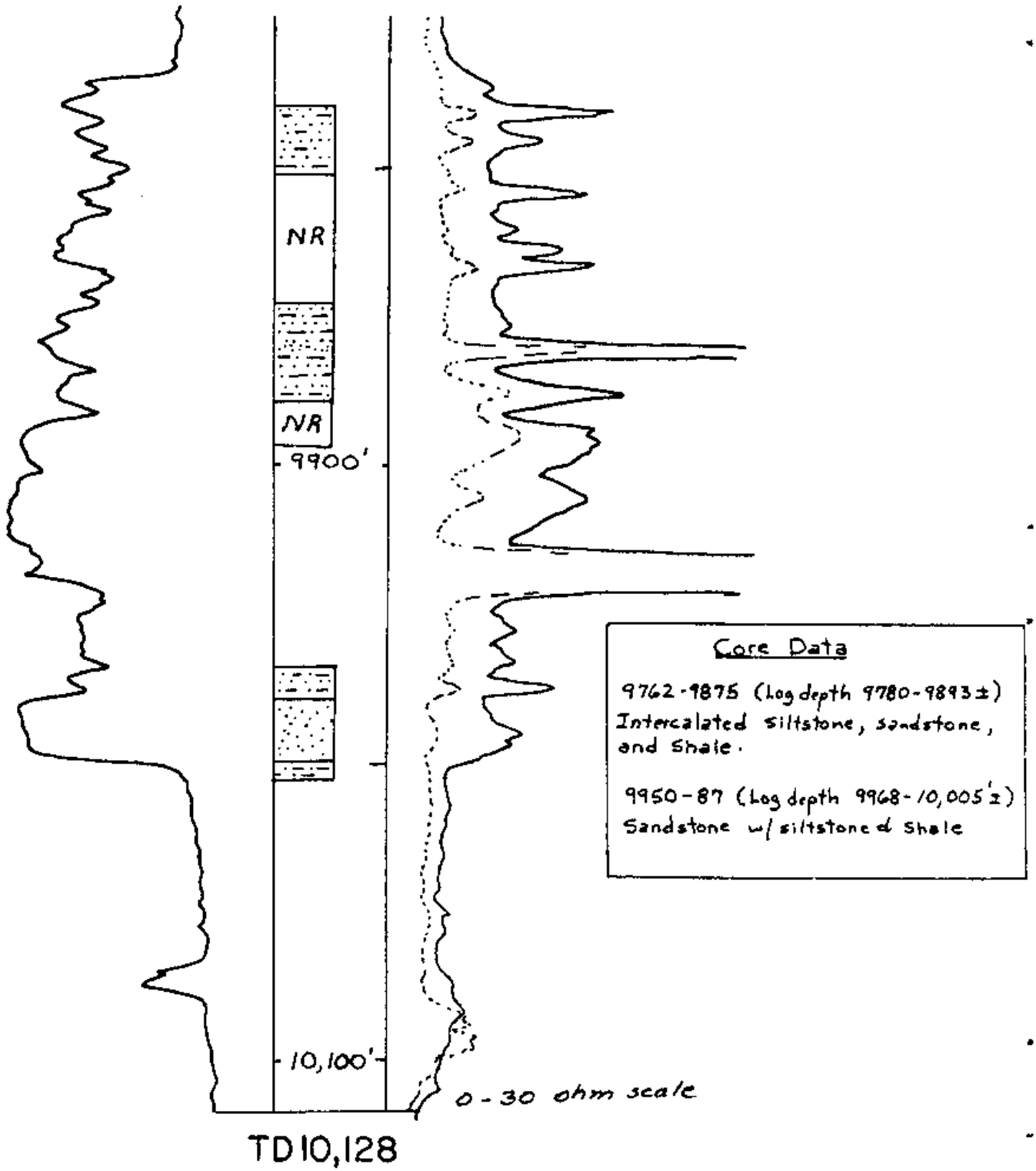
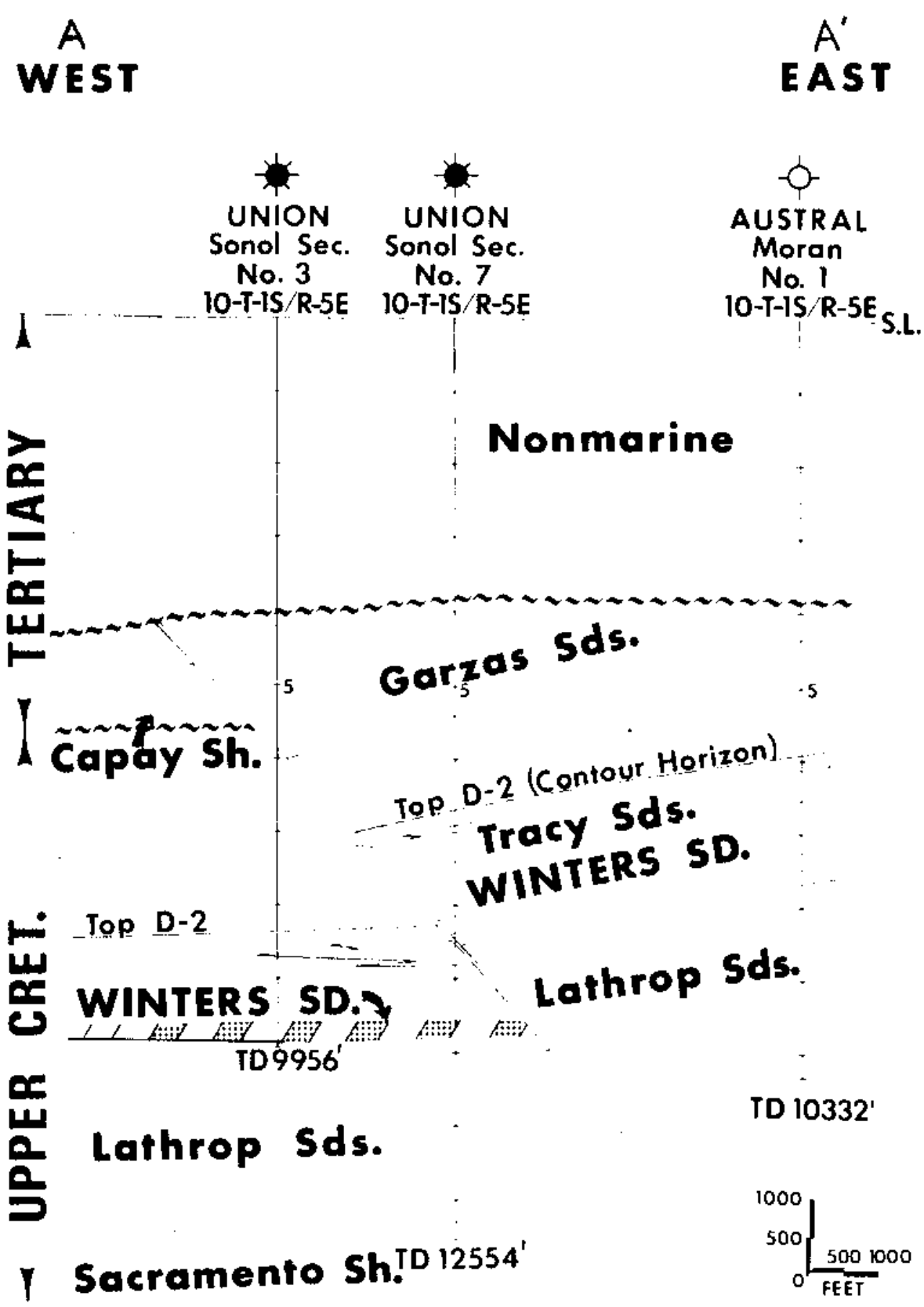

UNION
Sonol Sec. No. 6
4-1S/5E
NR
NR
9900'
10,100'
TD 10,128
0-30 ohm scale
Core Data
9762-9875 (Log depth 9780-9893±)
Intercalated siltstone, sandstone, and shale.
9950-87 (Log depth 9968-10,005'±)
Sandstone w/ siltstone & shale

Fig. 6



UNION ISLAND FIELD
W-E Structural Cross Section

Fig. 7

UNION ISLAND FIELD
Contours Top
Winters Sd.

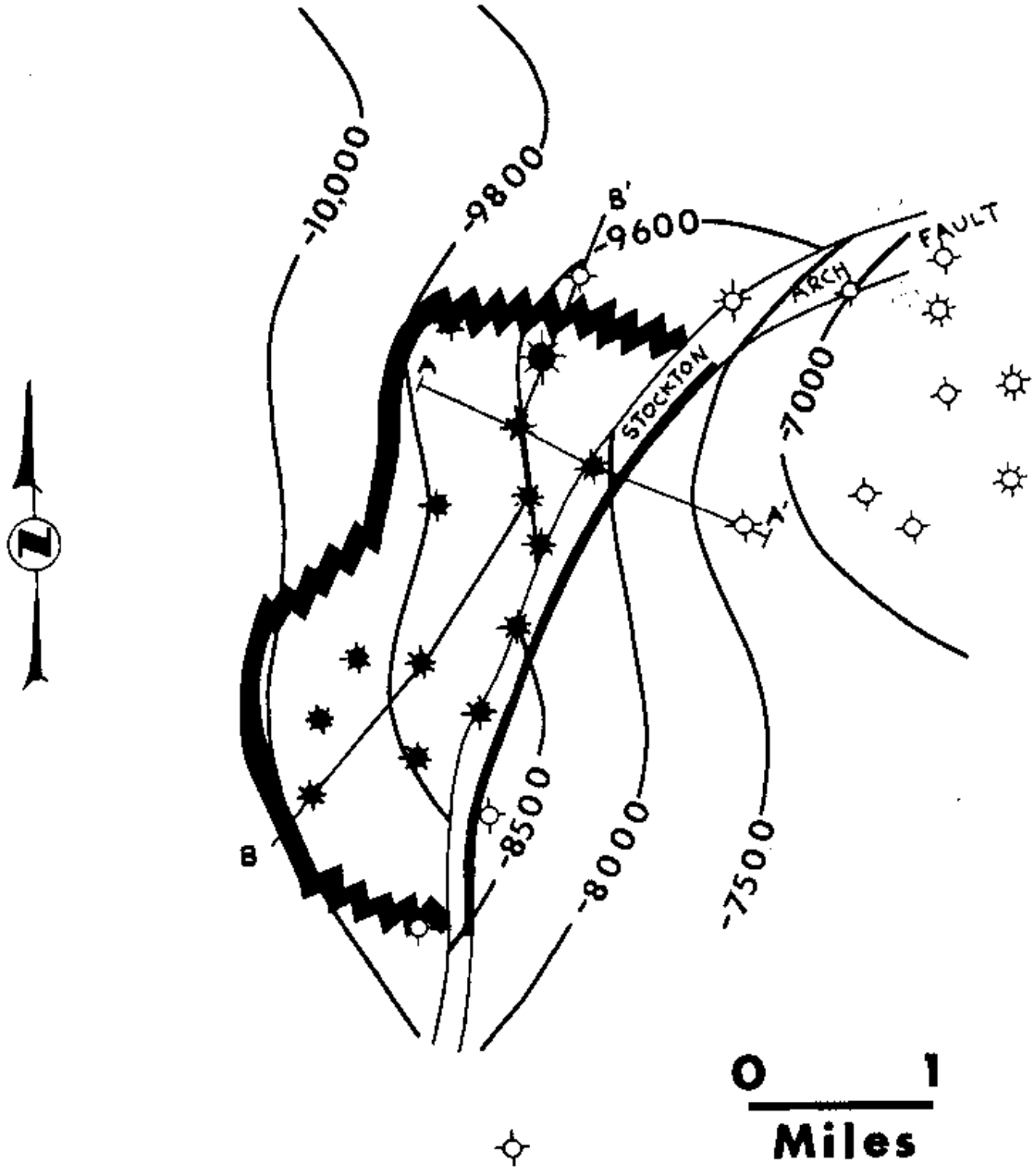


Fig. 8