"AFRICAN" METAMORPHIC TERRANE OF PROTEROZOIC AGE IN PENINSULAR FLORIDA AND ENVIRONS

George O. Winston

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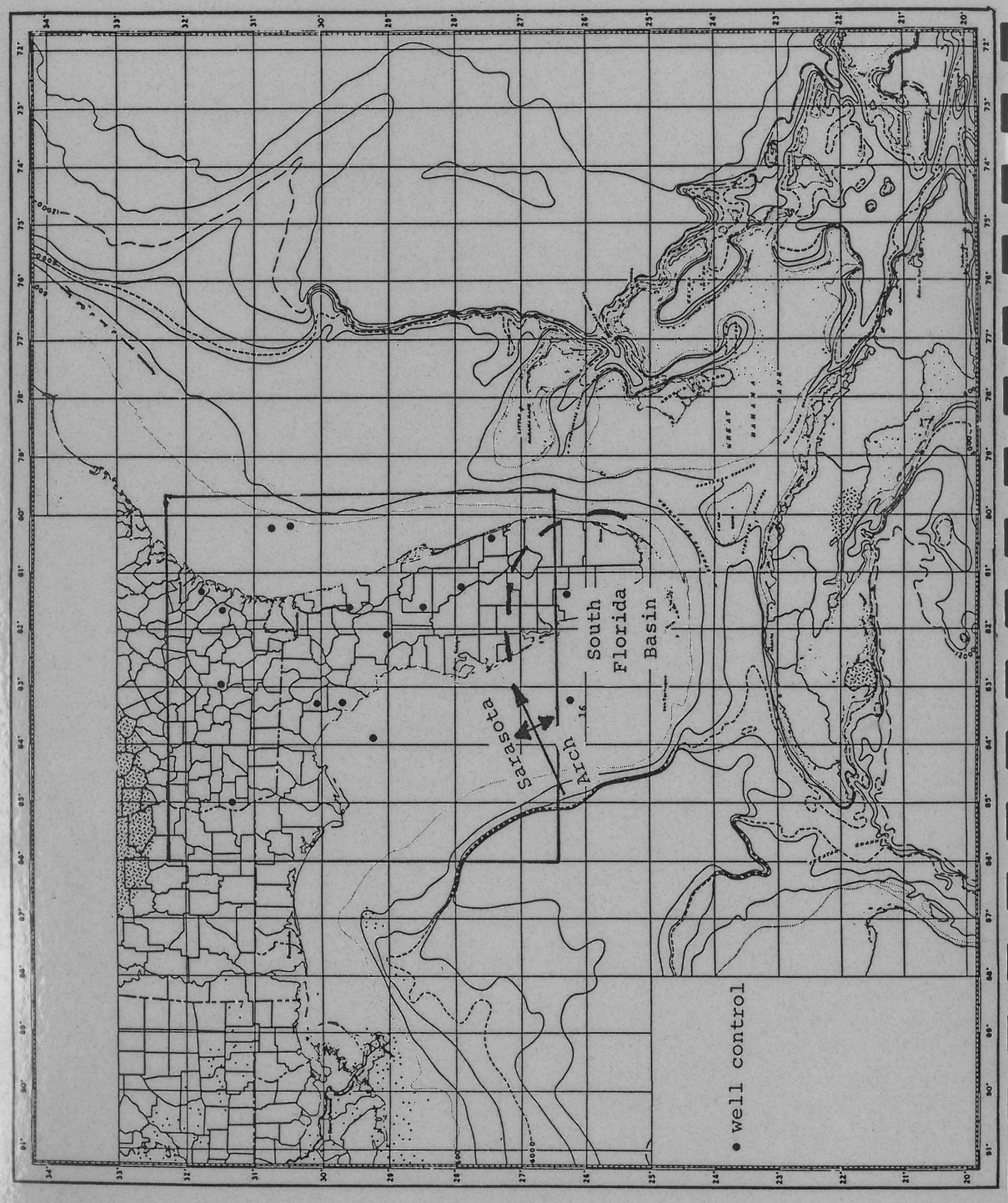


Area of Interest

Fig. 1

TABLE OF CONTENTS

Figures

ABSTRACT

A high and low-grade Gondwanan metamorphic terrane is revealed by 14 wells in Florida and environs. Two high-grade metamorphics (gneiss and schist) are located in central Florida and are probably Early Proterozoic in age. The 12 other wells contain low-grade metamorphic suites, principally composed of inter-bedded argillites, acid volcanics and quartzites belonging to the Mauritanid sequence of West Africa. These suites are present in south Georgia, north Florida and offshore; a 3975-foot section was penetrated in one well. These widespread metamorphic rocks are probably the terrane into which the Cambrian Osceola granite of central Florida was intruded. The two grades of metamorphics represent Early and Late Proterozoic episodes of sedimentation, each followed by metamorphism and erosion. Lower Ordovician to Devonian sediments were deposited on this terrane in southern Georgia and northern Florida. In the Early Jurassic, volcanics completely covered southern Florida, concealing the nature of the old underlying surface. Younger Mesozoic sediments eventually buried the entire Pre-Cambrian-Lower Jurassic terrane.

ACKNOWLEDGEMENTS

I wish to express my appreciation for the helpful comments and suggestions made by F.W. Meyer, D.R. Moore and J. Labowski, who reviewed this paper for the Miami Geological Society, and to Petroconsultants, S.A., Geneva, Switzerland, for their permission to abstract certain data from the detailed report "Basement Character & Paleozoic Stratigraphy of Southern Alabama, Southern Georgia & Florida" which was prepared for them by R.H. Lindsey and myself.

Last, but not least, this paper would not have made it through the numerous revisions were it not for the patient word processing of my wife Mary.

PREFACE

A 1987 Report on the Republic of Guinea by Petroconsultants S.A., Geneva, Switzerland (no stated author) has the following to say about a local Proterozoic-age metamorphic rock which is very similar to that found in Wells 1, 6, 8 and 9.

> "Thick sedimentary, volcanic and intrusive rocks affected by low-to medium-grade metamorphism and generally attributed to the Proterozoic constitute the Guinean portion of the Mauritanid foldbelt...." *
>
> "The rock material .... of Guinea consists of a layered sequence of sedimentary and volcanic origin that has been tightly folded, metamorphosed and intruded by granite. A general "Panafrican" (Late Precambrian) age is indicated for (these) tectonic and magmatic processes."
>
> "....the main part of the (metamorphic) Group (is) composed of rather uniform silty-argillaceous shales of dark greenish-gray to violettish colour...(and reaches)... thicknesses of nearly 1,000 meters (with) subordinate intercalations of fine-grained sandstone...."
>
> "The Coyah granites, which are directly overlain by Ordovician sandstone, gave given a radiometric date of 589 MY..."

* Figure 3 shows the extent of the Mauritanid metamorphics.

INTRODUCTION

This paper is based on lithologic research by myself with contributions by R.H. Lindsey (see Table 1). As 7 of the 14 wells discussed have been drilled since the last published study of Florida Basement rocks (Barnett 1975), it seems appropriate to undertake this presentation, and attempt a Pre-Cambrian geologic history.

METAMORPHIC STRATIGRAPHY

The high-grade and low-grade metamorphic rock suites in the Florida peninsula and environs were once part of the well-documented Mauritanid metamorphics of the West African Gondwana continent (Fig. 2).

Source of Data

A total of 14 wells in Florida and environs (Fig. 2, Table 1), 11 onshore and 3 offshore, reached a volcanic-metamorphic basement section that is definitely Pre-Lower Ordovician, and most certainly is Proterozoic.

The first well to penetrate this terrane was the Humble 1 Carlton (Well 13) drilled in 1945, penetrating 37 feet of greenschist. The latest was the Sohio OCS 6456 drilled in 1985. It penetrated 3974 feet of low-grade metamorphics and volcanics (Suite 2).

High-Grade Metamorphics

Obviously these are the oldest rocks, which must be at least of Middle Proterozoic age. The Sand Lake disposal well (Well 12) penetrated 69 feet of green schist overlain by Upper Cretaceous Tuscaloosa. The Humble 1 Carlton (Well 13) penetrated 37 feet of

greenschist beneath some 400 feet of basalt (Lindsey pers.comm.). No age dates are available for the basalt, but it is probably part of the Lower Mesozoic volcanic flows which cover most of the onshore South Florida Basin.

These high-grade metamorphic rocks would appear to belong to very ancient mountain ranges.

Low-Grade Metamorphics

These less indurated and probably younger metamorphics are grouped into two Suites: Suite 1 consists of interbedded argillite and quartzite; Suite 2 is the same with the addition of rhyolite.

Suite 1 is present in Wells 9 and 6. Well 9 (Amoco 1 Buckeye) penetrated 1415 feet of dark gray, red, and dark green argillite. This section is overlain by 2740 feet of Lower Ordovician sandstone and quartzite, the lower 300 feet of which is conglomeratic. The sequence of rocks in this well is important regionally as it establishes a Pre-Ordovician and probable Proterozoic age for the argillites.

Offshore to the east, Well 6 (COST GE-1) penetrated 2125 feet of a similar section consisting of pale green, purple, lavender and maroon argillite interbedded with gray-green, green and red fine to medium grain quartzite. Although dated as Devonian by radiometrics (Simonis 1979, an age considered doubtful by him), the lithologic similarity of this section to the West African Mauritanids (Fig. 3) and the sedimentary sequence in Well 9 (above) indicates that these rocks must also be Proterozoic in age.

Suite 2 is present in Wells 1, 8 & 7. Well 1 (Exxon 1 Wilson) penetrated 1523 feet of section consisting of red argillite and red fine to medium grain sandstone with exotic grains, overlying bright red rhyolites and gray andesites. This section is in turn overlain by 1290 feet of Lower Ordovician quartzite and quartzitic conglomerate, establishing an older and undoubtedly Proterozoic age for the underlying low-grade metamorphics.

Well 8 (Sohio OCS 6456) penetrated 3974 feet of interbedded rhyolite, well-indurated shales and sandstones, and an occasional quartzite and congromerate. The rhyolites are dark red splotched with gray, dark green, and gray. The well-indurated shales are dark red, green and greenish gray. The quartzites and well-indurated sandstones are very fine to fine grain and are dark red, and mottled green and white. The sandstones occasionally contain exotic grains, including igneous fragments. Conglomerates are varicolored and also include exotic grains. As in Wells 9, 1 and 8, the section is overlain by Lower Ordovician varicolored quartzite, sandstone and siltstone (2765 feet), the lower 800 feet of which is a conglomerate.

Well 7 (Exxon OCS 3705) penetrated 608 feet of Proterozoic section. The upper 270 feet consists of gray and green highly-indurated fine grain to silt quartzite. This overlies 338 feet of pink rhyolite. The quartzites appear to be more highly indurated (the grain structure is barely discernible) than do the white and light gray Lower Ordovician quartzites in wells ten miles to the west. This Pre-Cambrian section is overlain by

Jurassic Haynesville-equivalent clastics.

In Well 14 (Amerada 2 Cowles), the igneous basement rocks were given differing descriptions by Bass (1969 gneiss) and Milton (1972 granite). Unmentioned by either is an eleven-foot section between an overlying basalt (presumably Jurassic) and the underlying granite/gneiss. This eleven-foot section consists of dark green argillite streaked with purple, a lithology very similar to that in Well 6. The presence of argillite this far south implies a widespread original distribution for the low-grade metamorphic terrane. At Well 14 the terrane was apparently almost eroded away before being covered by Jurassic basalt.

The Osceola granite pluton (Wells 14 and 17), dated around 530 MY (Cambrian) must have had several thousand feet of insulating overburden to allow it to crystallize. From the data in Well 14, the overburden would appear to have been the low-grade metamorphic Mauritanid sequence.

Volcanics

Well 5 (Amoco 1 Crapps) encountered 113 feet of greenish andesite (Lindsey pers. comm.) beneath 5340 feet of "African" Lower Ordovician and younger Paleozoic sediments consisting of variegated and occasionally quartzitic sandstones. Again a Paleozoic cover establishes the andesite as Pre-Ordovician and probably Proterozoic.

Well 11 (Sun 1 Camp) cored 22 feet of golden brown rhyolite overlying a rhyolite conglomerate. This volcanic section is overlain by 365 feet of "African" Lower Ordovician quartzitic sandstone and conglomerate, establishing a probable Proterozoic

age for the rhyolite.

Well 10 (Thayer 1 Johnson) penetrated 1120 feet of volcanics (Fig. 4) consisting of 490 feet of andesite (Lindsey pers.comm.) overlain by 630 feet of rhyolite. Within the rhyolite section are two red shales at 4500 and 4570 feet (Fig. 4). These might be construed as cavings from up-hole, except for the fact that there are no younger red shales in this part of Florida. The E-log character confirms the presence of the shale.

As the volcanics in Wells 11 & 5 are older than Lower Ordovician and presumably Proterozoic in age, it is reasonable to assign a probable Proterozoic age to the volcanics in this well.

Wells 2, 3 and 4 in Georgia all bottomed in rhyolite (Lindsey pers. comm. and Applin 1951), with penetrations of 34 feet, 4 feet and 73 feet respectively. No dating is available, either stratigraphic or radiometric; considering the regional setting (Chownes & Williams 1983) these rhyolites are also probably Proterozoic in age. They are all overlain by Late Cretaceous rock.

GEOLOGIC HISTORY

In the Early Proterozoic of Gondwana, older clastic sediments were highly metamorphosed in a mountain-building event (Dallmeyer et al 1987) (Wells 12 & 13, Fig. 2). After a long period of erosion during which more clastic sediments were eroded from these metamorphics deposited during the Middle to Late Proterozoic. At the same time multiple volcanic events contributed rhyolite and probably volcanic ash deposits. In the Late Proterozoic, these sediments and volcanics (Mauritanid Complex) were mildly metamorphosed (Dallmeyer et al 1987). These rocks were then subjected to more erosion (Wells 1, 6, 7, 8, 9 & 14) were then subjected to another period of erosion.

In the Middle Cambrian (Bass 1969), this terrane was intruded by the Osceola Granite pluton (Wells 17 & 14).

After further erosion, "African" Paleozoic clastic sediments were deposited on the Proterozoic surface in northern Florida, and probably in the South Florida Basin. This latter possibility is suggested by the presence offshore of Paleozoic sedimentary rocks in Well 16 (Fig. 1) on the south flank of the Sarasota Arch.

In the Devonian, following the collision of North America with Gondwana to form Pangea, deposition ceased; the only remaining geologic process was erosion. In the Permian (Exxon pers. comm.), granite (Well 15) intruded whatever rock underlies the Mesozoic volcanics in south Florida.

During the rifting of North American from Pangea in the Lower and Middle Jurassic, volcanic flows covered most of the

South Florida Basin.

After further erosion during the Lower and Middle Jurassic, marine transgression, beginning in the Upper Jurassic, had by the late Cretaceous covered the entire Paleozoic-Proterozoic surface with sediments.

BIBLIOGRAPHY

Applin, P.L., 1951, "Preliminary report on buried pre-Mesozoic rocks in Florida and adjacent states," USGS Cir. 91, 28p.

Arthur, J.D., 1988, "Petrogenesis of Early Mesozoic tholeiite in the Florida Basement, and an Overview of Florida Basement Geology, FL Geol. Surv., RI 97, 39 p.

Barnett, R.S., 1975, "Basement structure of Florida and its tectonic implications" GCAGS Trans. p. 122-42.

Bass, M.N., 1969, "Petrography and ages of crystalline basement rocks in Florida", AAPG Mem. 11, p. 283-310.

Chownes, T..M. & Williams, C.T., 1983, "Pre-Cretaceous rocks beneath the Georgia Coastal Plain - regional implications", USGS Prof. Paper 1313-L, 42 p.

Dallmeyer, R.D., Caen-Vachette, M. & Villeneuve, M., 1987, "Emplacement age of post-tectonic granites in southern Guinea (West Africa) and the peninsular Florida subsurface", Bull. GSA, V. 99, p. 87.93.

Milton, C., 1972, "Igneous and Metamorphic basement rocks of Florida", FL Geol. Surv., Bull. 45, 125 p.

Milton, C. & Grasty, R., 1969, "Basement rocks of Florida and Georgia", AAPG Bull., p. 2483-93.

Scholle, P.A. (editor), 1979, "Geological studies of the COST GE-1 Well, United States South Atlantic outercontinental shelf area, USGS Surv., Cir. 800, 114 p., 13 papers.

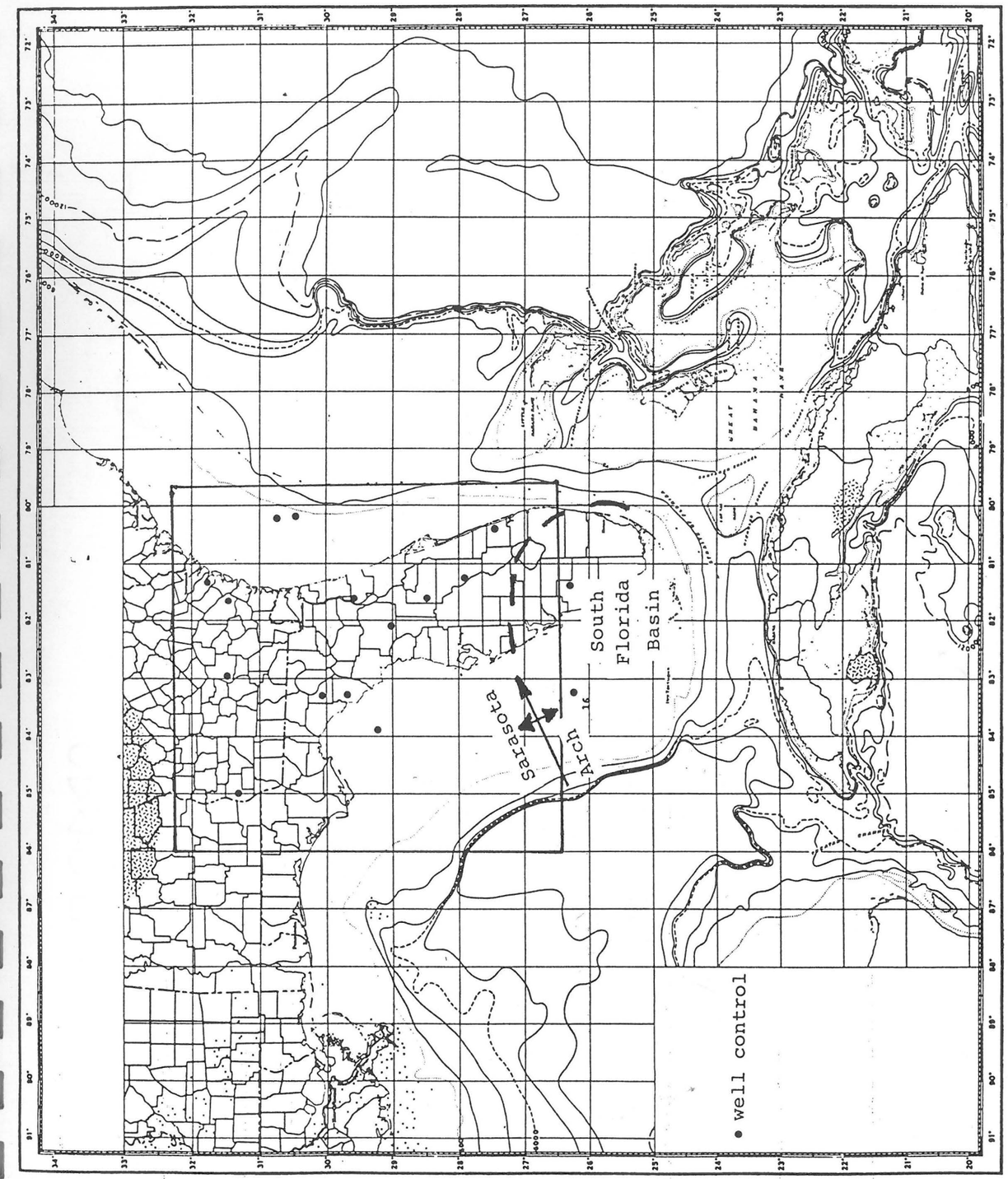
Smith, D., "Review of tectonic history of the Florida basement", Tectonophysics, v. 88, p.1-22.

Wicker, R. & Smith, D., 1978, "Reevaluating the Florida basement", GCAGS Trans., p 681-87.

Table 1

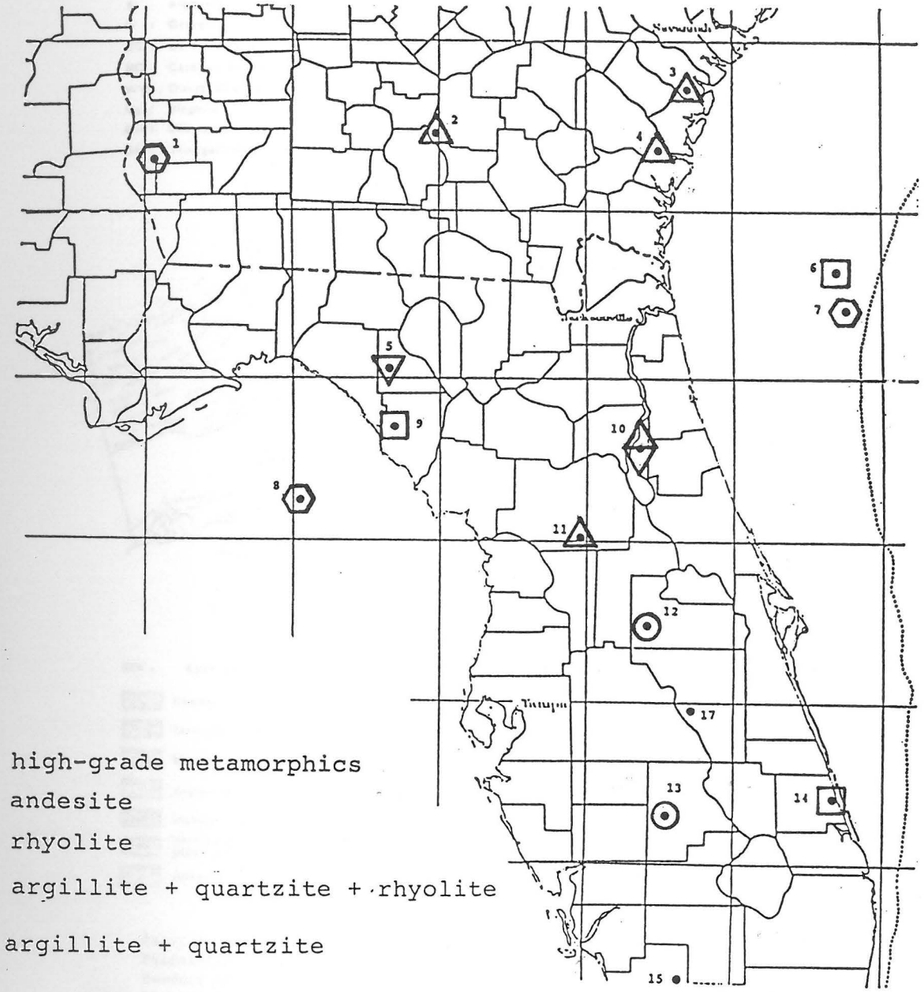
WELL LIST

Map No.	State No.	Operator	Well	Examined by GOW	Examined by RHL	Basement Penetration
1	3543	Exxon	1 Wilson	x		1533
2	3127	Chevron	1 Fussell		x	32
3	373	La Rue	1 Jelks		x	44
4	1197	Pan Am	1 Union		x	73
5	1052	Amoco	1 Crapps	x	x	113
6	--	COST	OCS GE-1	x	x	2175
7	--	Exxon	OCS 3705	x		608
8	--	Sohio	OCS 6456	x		3974
9	1129	Amoco	1 Buckeye	x		1415
10	607	Thayer	1 Johnson	x	x	1120
11	53	Sun	1 Camp		x	22
12	W13287	Sand Lake	1 disposal	x	x	69
13	W966	Humble	1 Carlton		x	37
14	259	Amerada	2 Cowles	x	x	11
15	1042	Exxon	20-2 Collier		x	208
16	--	Tenneco	OCS 3917	x	x	240 Pz
17	539	ARCO	1 Bronson	x	x	35



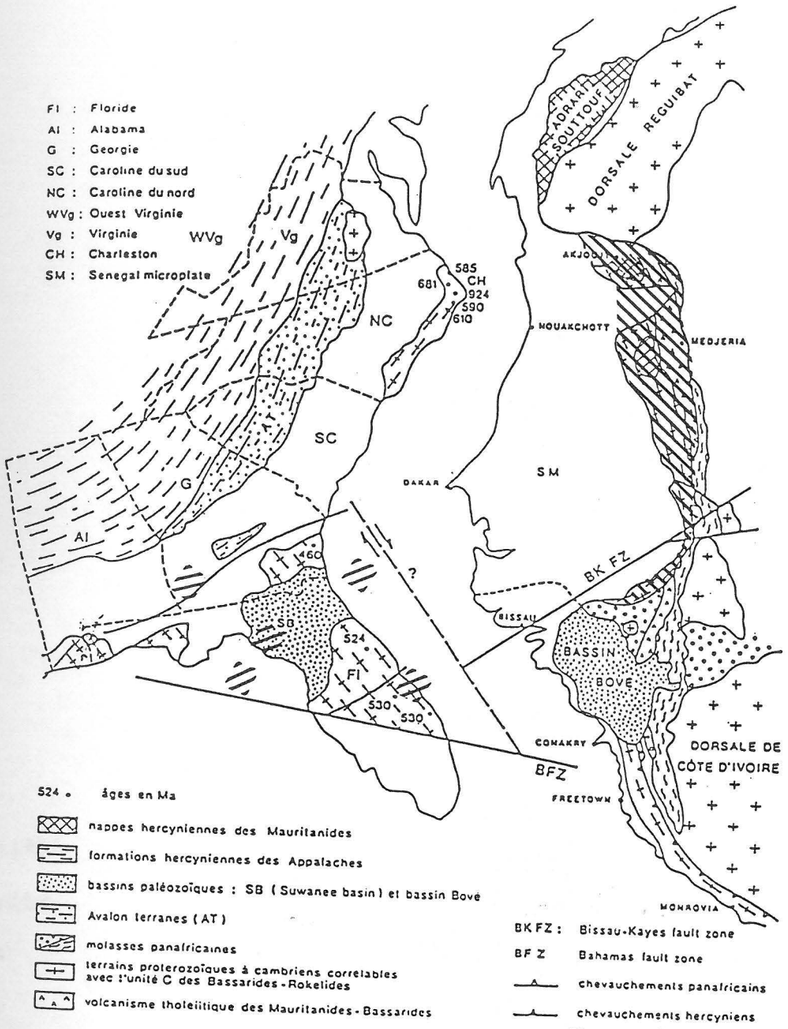
Area of Interest

Fig. 1



Distribution of Pre-Cambrian Metamorphic Rocks

Fig. 2



after Villeneuve 1984

Essai de corrélation entre les formations du Précambrien supérieur et du Paléozoïque de la bordure occidentale de l'Afrique de l'Ouest et de la bordure orientale de l'Amérique du Nord (chaînes du Précambrien supérieur et hercyniennes)

Mauritanid suite in Africa

Mauritanid suite in SE U.S.

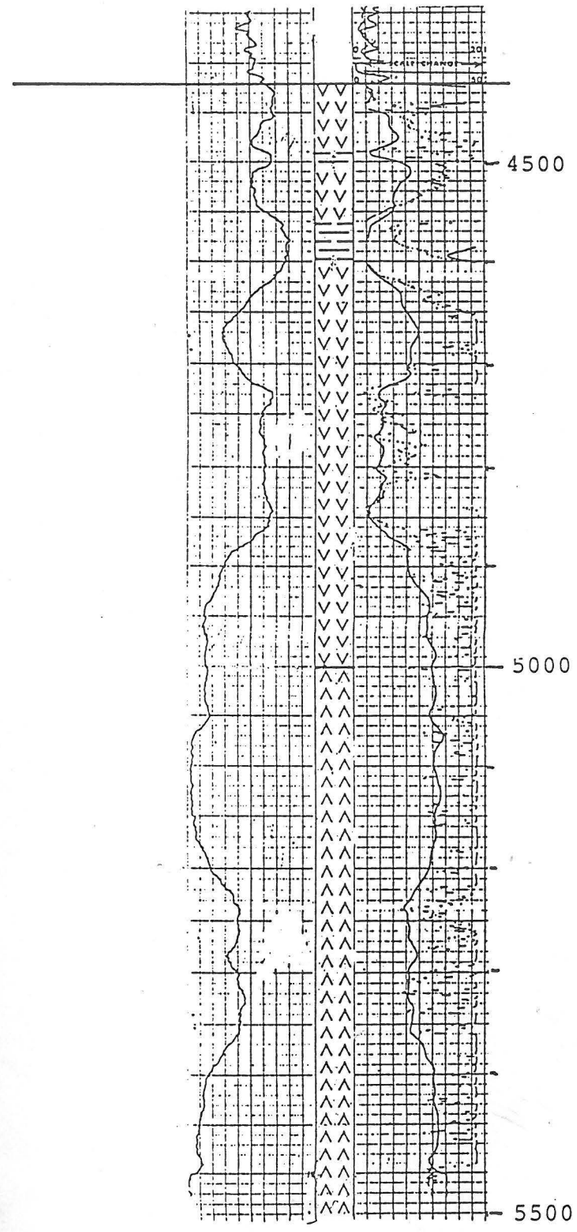
Relationship of the Geology of West Africa and Florida

Fig. 3

10

Thayer & Davis

1 Johnson



vvv
vvv rhyolite

^^^
^^^ andesite

shale

Litho-E-log of Well 10

Fig. 4