

The Joins and Tulip Creek Formations are limited essentially to the southern half of Oklahoma as a result of non-deposition and only locally by erosion from the Ozark uplift in Black Riveran time. Absence of the Corbin Ranch Formation locally below Viola strata in the Arbuckle and eastern Wichita Mountains is evidence that minor incipient tectonism of these elements occurred in post-early Trenton time.

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"Mesozoic Igneous Activity in the Northern Gulf Coastal Plain"

Igneous rocks of Mesozoic age occur at widely scattered localities in the central part of the United States. Some of the surface exposures, such as the intrusive stocks at Little Rock and Magnet Cove, Arkansas; the peridotite pipes near Murrefreesboro, Arkansas; and the lamprophyric dikes of southern Illinois have been known for many years. Deep drilling in the Northern Gulf Coastal Plain has shown the presence of many additional igneous occurrences, particularly in the Monroe uplift and Jackson dome. More than 100 wells have encountered primary igneous rocks, and many others have penetrated pyroclastic debris.

The diabase province includes at least 14 known occurrences in northeastern Texas, southwestern Arkansas, and western Mississippi. None of these rocks are exposed at the surface. They occur as thick dikes and sills in the Eagle Mills or at the base of the Cretaceous where the Eagle Mills has not been encountered. The age is pre-Upper Jurassic and may be the same as the similar Triassic diabases of the eastern United States. They represent relatively rapid emplacement of a basaltic magma into zones of tensional movement.

The alkaline province includes a greater variety of igneous rocks ranging from the truly alkaline rocks (nepheline syenite, tinguaitite, phonolite, etc.) to normal syenites, lamprophyres, peridotites, tuffs, and volcanic breccias (diatremes). The age of emplacement ranges from lower Woodbine to lower Taylor, based on the intrusive relationships and the associated tuffs. The activity thus occurred during a relatively long geological span, during which there was sufficient magmatic differentiation to produce a variety of rock types.

There appears to be little relationship between the presence of igneous rocks and the general absence of oil or gas, except in a few places where larger dikes and stocks have caused rather severe metamorphism. The presence of relatively thin dikes and sills, such as those encountered in the Big Creek-Delhi field of northeastern Louisiana or the Omaha pool of Galatin County, Illinois, seems to have had little effect on the producing capabilities of otherwise favorable reservoir rocks. As a general rule, the width of the zone adversely affected by an intrusion is no greater than the thickness of the intrusive itself.

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Broken Arrow

"Women in Exploration"

Petroleum geology as a science had its beginning in the minds of geologists even before the discovery of oil in the Drake well in 1859. In 1848 Sir William Logan, director of the Geological Survey of Canada, visited oil seeps of the Gaspé Peninsula and pointed out that these seeps were on anticlines. T. Sterry Hunt of the Canadian Survey gave the first clear formulation of the Anticlinal Theory in 1869 and concluded that the following conditions were necessary for oil accumulation.

1. A source bed.
2. Proper attitudes of strata.
3. Suitable fissures to act as reservoirs.
4. Impervious strata above and below the oil bearing zone.

It was left to I. C. White to reaffirm the anticlinal theory in 1882 and prove the practical application of the theory with the discovery of gas on three out of four anticlines drilled in West Virginia in 1888.

This theory was opposed by many geologists, because much of the oil in Pennsylvania was not found on anticlines. As more and more geologists left surveys and entered into oil exploration other theories such as the trap theory were advanced. There was extensive surface and subsurface mapping, stratigraphic studies with sample examination, and the extensive use of micropaleontology followed by various kinds of geophysical mapping and electrical logging that helped in interpretation of geological conditions.

The science has advanced with industry advancement and we find specialists in various fields.

The first petroleum geologists came from state and national surveys and the teaching profession.

Florence Bascom, instructor in geology at Bryn Mawr and on the staff of the U. S. G. S. in 1894, became the first woman to be elected a fellow of the Geological Society of America, followed by Ida Helen Ogilvie of Barnard College in 1906. Then came Marjorie O'Connell in 1919, Julia Gardner and Carlotta Maury in 1920, all essentially interested in teaching or stratigraphy.

When I first entered the profession in 1921 eight women were listed as members of the Paleontological Society, two with oil companies: Miss Alva Ellisor with Humble and Miss Esther Richards (later Mrs. Paul Applin,) Rio Bravo Oil Company.

The first women were elected to membership in the A.A.P.G. in 1919, three with Roxana (now Shell) and three with Empire Gas and Fuel Company (now Cities Service).

The 1921 membership reveals that there were at that time 12 women members of the A.A.P.G. One-half of these continued in the profession: Constance Eirich with the Gypsy, Vita Lee Chase with Carter, and Dollie Radler with Amerada, all of Tulsa; Alva Ellisor with Humble, Hedwig Kniker with The Texas Company, and Esther Richards with Rio Bravo, all of Houston.

The 1965 membership list shows that 152 members are women. Approximately one-half are engaged in exploration with oil companies. Throughout the years women have constituted slightly less than 1 per cent of the membership.

In spite of the small number, some have had very interesting careers. More women have entered the stratigraphic field than any other, as micropaleontologists, stratigraphers, sample examiners and allied fields. The outstanding woman in this field was the late Alva Ellisor who was among the first women, and one of the most famous, stratigraphers in the country. Her life was devoted to stratigraphic research and her many publications on the Cretaceous and Tertiary stratigraphy and paleontology of the Gulf Coast are a fitting memorial to her. With the exception of a short period of teaching at the University of Kansas and a short while with the Kansas Survey she spent her working years with Humble. She

organized their paleontological laboratory in Houston for the examination of megascopic fossils, later expanding it into a microscopic laboratory and stratigraphic research center. She is believed to be the first woman to examine well cuttings and the first person to recognize the importance of foraminifera in wells along the Gulf Coast.

In 1925 she collaborated with Esther Applin and Hedwig Kniker in publishing an outstanding paper, "Subsurface Stratigraphy of the Coastal Plain of Texas and Louisiana" (A.A.P.G. Bull., Vol. 9, No. 1, Page 79-122). In my early years as a geologist the names of these three women became well known in our office because Sidney Powers recognized the enormous contribution that they were making to the stratigraphy of the Gulf Coast. Their contributions added much to our knowledge of the stratigraphy of the Tertiary and Cretaceous.

There are many husband and wife teams; Lou Henry received her degree in geology from Stanford University in 1898. Soon afterward she married Herbert Hoover and spent many years in far places around the globe. Undoubtedly her knowledge of earth sciences was of great value to her in her life with this great geologist, engineer, humanitarian and statesman.

Paul and Esther Applin, Fred and Helen Jean Plummer, W. Z. and Polly Miller are a few others. Polly is not a geologist but she tramped many a mile with W. Z. as his instrument man when he was conducting surface geological mapping.

Fannie Carter Edson began her professional career in mining geology in the United States and Mexico. She entered petroleum geology as a stratigrapher with Shell, and later performed subsurface and stratigraphic studies in Kansas, Oklahoma and Illinois for independents. Her contributions to the stratigraphy from Permian to Precambrian are well known. She was the first to use heavy minerals as an aid to determination of age.

Although Helen Martin with the Michigan Survey did her early work in subsurface with Carter Oil Company, her compilation of the geological map of Michigan and her outstanding work with the survey has helped many geologists in that state.

In almost every state survey and the United States Geological Survey we find women geologists who have contributed much to our understanding of the geology. Julia Gardner, Leona Boardman and Florence Bascom with the U.S.G.S., Helen Bal-

yea with the Geological Survey of Canada, Mary McCracken, Missouri Survey, and Winnie McGlammer with the Alabama Survey, to name a few.

Dr. Louise Jordan started her career as a teacher, later joined an oil company, and now is with the Oklahoma Geological Survey. She belongs to that exclusive group that traveled around the world to attend the recent International Geological Congress in Italy, was trapped by snowstorms at Sinagar and held its own Congress. She is both academic and personal counselor to all graduate students in geology and edits their manuscripts. She is author and co-author of many publications of the survey.

Katherine Carmen, now retired in Denver, is an outstanding example of one of the few who mastered surface mapping.

Alice Langlois worked part time for the oil division of Newmont Mining Company while completing requirements for her degree at Columbia University. She became manager of their exploration department. She took early retirement and now lives in Paris, France.

The first woman member of the Tulsa Geological Society was Constance Eirich with the Gypsy Oil Company, now Gulf. Constance is now retired and lives at Van Wert, Ohio. She probably has found more oil with subsurface mapping than any other woman and was the first woman to be acting chief geologist of her company.

In 1926 an oil well was completed on the Nash dome in Fort Bend County, Texas, on a gravity maximum and is believed to be the first oil pool discovered by geophysical methods. This was followed by the first seismic discovery on the Orchard dome in Fort Bend County, Texas, in 1929.

These discoveries led to the wide use of geophysics in exploration. The Society of Economic Geophysicists was organized in 1930. Elizabeth Stiles of the Independent Exploration Company in Houston became the first woman member of this society; now retired, she still maintains her membership. Today out of a membership of 5600 there are 14 women, 11 of whom are with exploration companies or oil companies, one in polar exploration, one in oceanographic research and one with the U.S.G.S.

Grace Hower is a member of both the Geological and Geophysical Societies of Tulsa. Grace finished her education at Columbia at the depth of the depression and worked for a time in geological interpretation of areal maps without salary in order to prove that she could do the job. Later

with S.S.C. she conducted magnetometer surveys and worked as a computer on a seismograph party. When geologists were at a premium during the Second World War she returned to her first love, geology. She is now employed by Amerada. Her experience in both geology and geophysics makes her a valuable employee, especially in the coordination of geology and geophysics. Her hobby is adding to her rare collection of rocks and minerals, especially fresh water pearls.

Women have also been important in the fields of drilling and producing. One of the first women graduates from the University of Oklahoma was Linda Green Miller. Linda worked for a time in the subsurface department of Roxana. After the death of her husband she assumed the management of Miller Services in Amarillo. Her husband invented a special method for drilling gas wells in the Texas Panhandle. This service was expanded and widely used. Besides her active management of the company she was very successful in developing production of her own.

Another woman who has been in active management of an oil company is Jessie Dearing Kinley, "Miss Jessie" to her associates. When Mr. Nichols of Little Nick Oil Company at Chickasha died she assumed management. The company has continued to prosper under her management.

We find many women who have received degrees in geology or geophysics who are employed in many capacities in the various departments of oil companies. They rarely become active members of the societies or associations but their knowledge and ability is very valuable to their associates and their contributions to exploration are many and varied.

Numbered among this group are technical secretaries, librarians, file clerks, draftsmen, sample examiners, log interpreters, and programmers.

Few women whose field is examination of oil well cuttings go onto the well sites but two women that are known to geologists in this part of the country have been very successful and many companies desire their services above those of men available. Ellen Posey Bitgood started her professional career with Cities Service Oil Company in Bartlesville. For many years now she has maintained her office at Wichita Falls, Texas. Her knowledge of the stratigraphy of the area is unsurpassed and she probably has had as many successful completions as most men.

Margaret Lillibridge was originally in partnership with her husband Harry at Enid in their microscopic laboratory. Upon Harry's death she assumed active management and has continued in good weather and bad to be on many wells drilling in northwestern Oklahoma. She too is considered tops in her field.

Maria Spencer, now retired from Superior Oil Company, made stratigraphic studies throughout the Mid-Continent area and spent two years in Nassau when they were drilling in the Bahamas. Constance Leatherock, Betty Kellet Nadeau, Herberta Branson, Mildred Frizzell, and Suzanne Takken are well known for their contributions to stratigraphy, subsurface geology, and their publications are many and varied.

I would like to pay tribute to those women who are in exploration departments who are not graduates in geology but who have added to their education by attending night school and learning enough geology to become invaluable assistants.

The outstanding example of this category is Mary Whitehead. When I first knew Mary she was a secretary in the geological department of The Texas Company. She then joined the Dixie Oil Company, fore-runner of Stanolind, now Pan American. Mary was a source of information of every kind needed by geologists or geophysicists. There are few geologists in Pan Am or among the rest of us who do not owe her a debt of gratitude for her ability to come up with the right answer at the right time. Mary retired last year from the technical library at the Research Center of Pan American.

It has been shown that women have been active in exploration since the early twenties. While few in number they have entered and have been successful in almost all phases of geological and geophysical exploration.

Those of you who manage exploration departments will find that they are more valuable and do a better job than most men in positions that demand a great deal of detailed information and concentration. Few enter the field that are not seriously interested in it.

It was my good fortune to learn after entering the University of Oklahoma that two women, Linda Green and Grace Jennings, had preceded me in the field of geology and that they had found satisfactory employment with oil companies. Linda with Roxana and Grace with Marland.

Luck again was with me when I received my degree and found that there was an opening with Amerada Petroleum Corporation owing to the woman geologist having married and left the profession. To secure employment at a time of lowering oil prices with a young, successful oil company under the management of a young and aggressive group of scientists is more than luck. Surely a greater power was guiding my footsteps.

It has been my good fortune to work with and for the great of our profession, to have seen and been a part of the change from surface mapping through all the phases of exploration and research, and to be honored by you, my fellow geologists.

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