HOFSTRA HORIZONS

Research at Hofstra University

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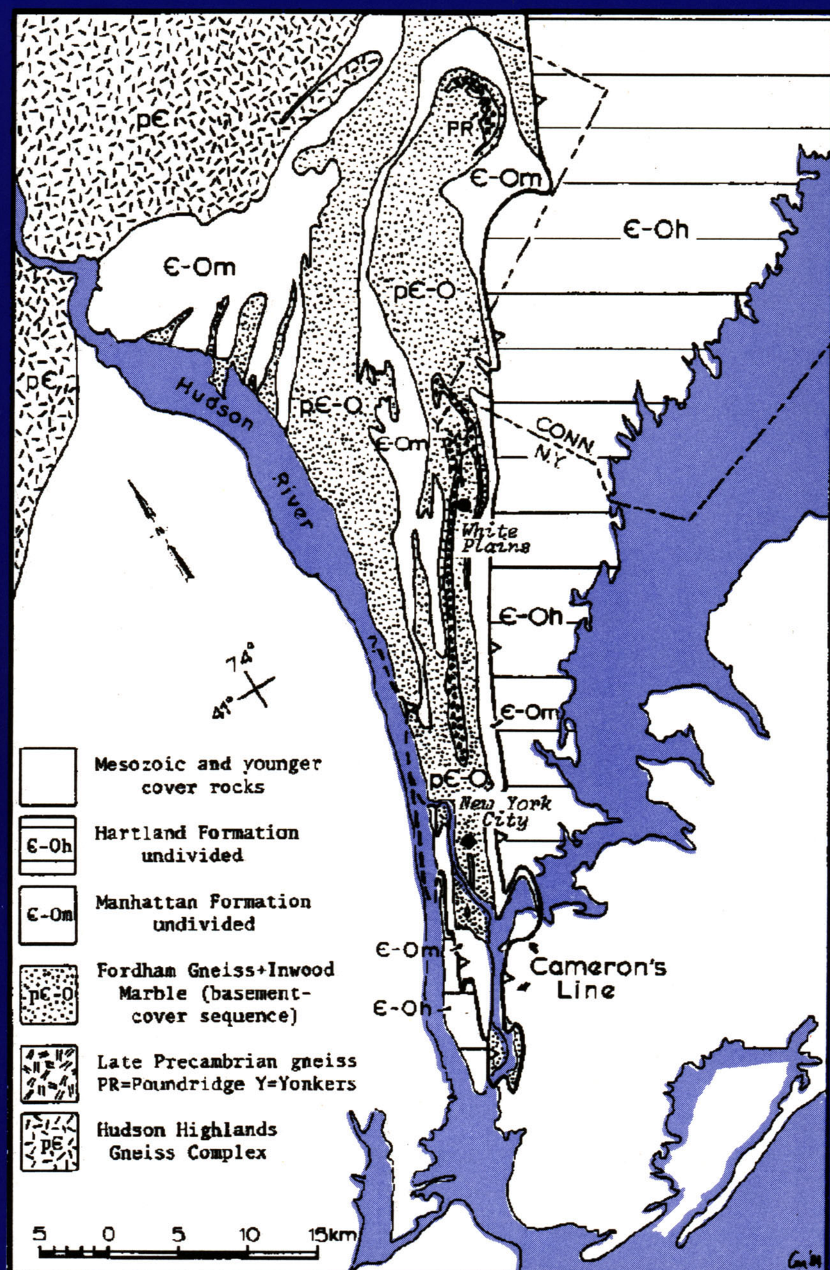


From California to New York, this "hard rocker" is redefining our understanding of past geologic events.

Charles Merguerian : Research into Rocks and Rumbles

Included among the rock specimens, shelves of books and journals and computer programs contained in the office of Geology Professor Charles M. Merguerian is his earthquake outfit. The image that comes to mind is of a hard hat, boots and seismic measurement devices. This outfit, however, consists only of a sports jacket and tie. Merguerian dons it quickly whenever an earthquake occurs anywhere in the world and waits for the media to show up. He has gained a reputation as one of the New York area's resident experts on the question, "Can it happen here?"

Merguerian has an insouciant manner that belies his extensive research background. Despite the media attention and drama, he considers earthquakes among the least interesting areas of geology. He traces his pursuit of the discipline to a childhood love of rocks; he could always be found examining the local outcrops behind his grandmother's house when he visited her in the Bronx. Originally setting out to study paleontology, his attention was diverted by a professor during his undergraduate years at the City University of New York. Rather than deepening his interest in fossils, he became a "hard rocker," specializing in igneous and metamorphic rocks. He thus distinguishes himself from the "soft rockers" who study sedimentary and coastal geology.

New England, specifically the geology of western Connecticut, was the location of Merguerian's earliest research projects. Like so many other scientists, he compares his work to that of Sherlock Holmes and other detectives. The rocks he deals with are deformed and folded by high temperature and pressure. The study of these materials requires keen observation, detailed knowledge of geophysical processes and deductive skills. The ultimate task is to take thousands of seemingly unrelated facts and correlate them into a single, unified theory. Merguerian's

Charles M. Merguerian

fascination with such complexity and preference for the outdoors led him to pursue extensive fieldwork when he went on to earn his Master's Degree, also at CUNY.

His undergraduate mentor became his graduate advisor. When it came time to begin work on the Master's thesis, that advisor voiced his doubts about the original mapping of an intrusion of rock in western Connecticut. Spending three summers mapping Litchfield County, Connecticut, Merguerian traced a fault known as Cameron's Line, and discovered that it served as a boundary between two plates that collided sometime in the geologic past. It separates rocks formed on North America from plates that moved from somewhere off the continent. Across Cameron's Line are a series of intrusions of anomalous rock known as the Hodges Complex. Merguerian's research task was to determine whether these variations represented physically transported slices of oceanic crust and mantle or whether they were genuine intrusions.

The thesis resulted in a reinterpretation of the geology of western Connecticut. It documented the first real evidence of what Cameron's Line is, of the relative ages of the subsurface rocks and what the intrusion represents in geologic history. Merguerian proved that the fault line, which extends into New York City, is not only a fundamental plate boundary that separates two distinctive sequences of rocks, but that it dates back to a time when there were excessive collisions taking place, approximately 480 million years ago. Merguerian is especially pleased with the fact that his Master's level work was used to update the official Connecticut state geologic maps.

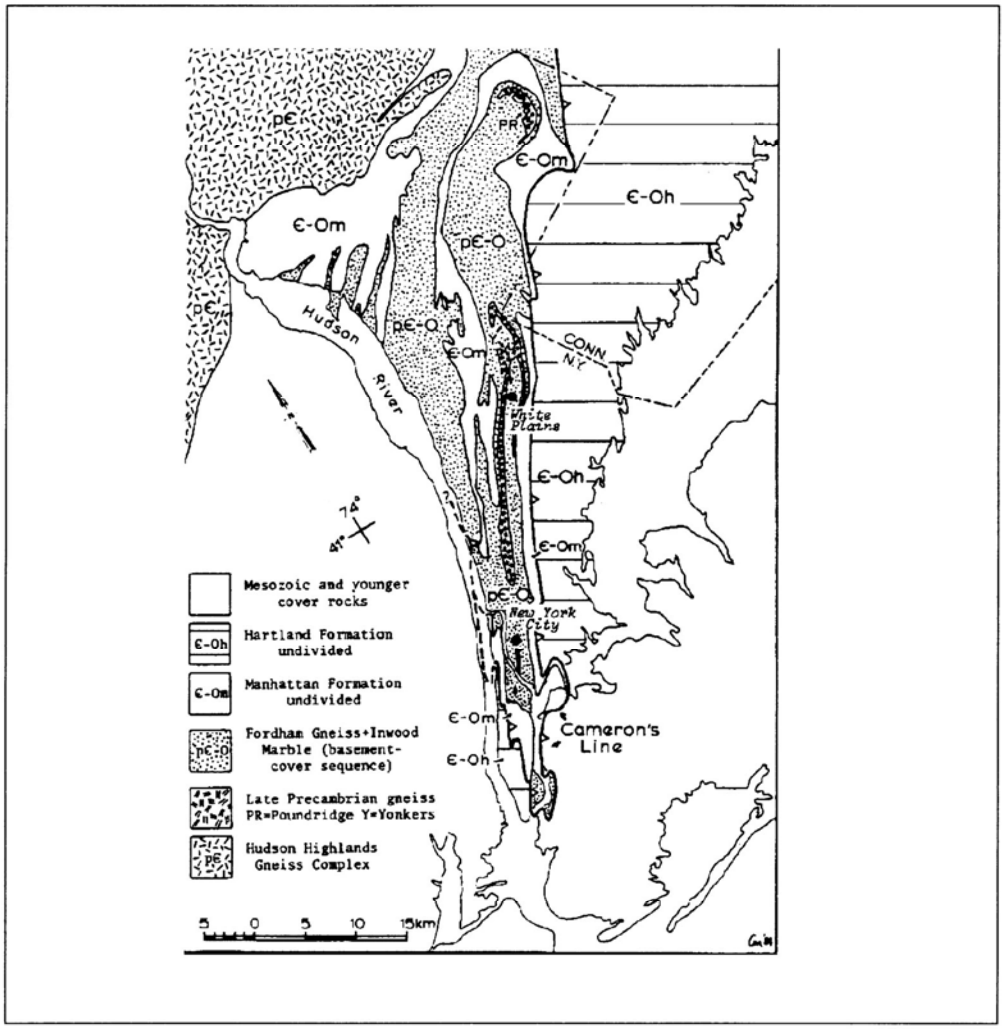
Continuing for the doctorate at Columbia University, Merguerian's work in Connecticut gave him the opportunity to conduct a similar project in the Sierra Nevada mountains in California. On the western flank of the Sierras exists a belt of metamorphic rock that had been all but taken for granted by the official geologic surveys of California. These rocks had not been studied since the 1800s. Even at that time, interest in them was economic rather than scientific. The area, of course, was the site of the California Gold Rush, and the belt that was the subject of Merguerian's doctoral dissertation contained rocks that were, in part, receptors for gold bearing fluids.

Finding himself in a gold mine of untapped geologic data, Merguerian began to apply his Appalachian techniques for the analysis of metamorphic rock formations. Similar to the work he conducted in Connecticut, his task was to investigate two dissimilar types of rock formation that were separated by a boundary. These are known as the Calaveras and Shoo Fly Formations. The boundary was not well defined either in terms of what it was or where it went. Merguerian's advisor had observed a fundamental difference in the texture of the rock, but he himself was not an expert in the application of Appalachian metamorphic techniques. The job took twelve months, spread over the course of four summers camping in the National Forest. At its conclusion, Merguerian had mapped over four hundred square miles of hitherto virgin terrain, with approximately fifty square miles documented in the most minute detail.

His findings were similar to those in Connecticut. The dissertation demonstrated the presence of a ductile contact, known as the Calaveras/Shoo Fly Thrust, which separated two metamorphic terrains of disparate age and equally different structural history. He defined the chronology of structural development and published a number of studies, some with colleagues, mapping contiguous areas, defining the rock units, their thicknesses, the structural geometry, the nature of the boundary and the dates of many of the intrusions. It was a comprehensive structural picture, including upper and lower age limits, that Merguerian refers to as "nuts and bolts" geology.

The findings showed a plate boundary between rocks that were indigenous to North America, the Shoo Fly complex, and the Calavaras complex, which proved to be completely exotic to this continent. The study revolutionized the awareness of the metamorphic history of the foothills of California. It was the first time geologists documented the existence of two distinct belts. Further research has revealed the existence of a third belt, all of them formed through the collisions of massive land movements in the earth's most distant past. Merguerian points out that the California work is not universally accepted. But he adds quickly that the detractors are not field geologists, but base their conclusions on geophysical data.

The work for these two studies took place between 1973 and 1981. Merguerian began his teaching career at Hofstra in 1981, a number of years before he actually concluded the data analysis and presentation to finish his Ph.D. He characterizes this period as a homecoming, both literally and intellectually. Even before completing the California study, he rekindled his childhood love of the geology of New York City. He bemuses the fact that the subsurface structure of the City had not been examined in over one hundred years, well before modern, sophisticated analytical techniques were developed. Merguerian's experience and expertise led him to go beyond previous descriptions, which were narrowly focused, and approach the geology of New York City from a regional perspective. His interest is in how the smaller area relates to the larger region.



Simplified geologic map of the Manhattan Prong showing the distribution of Precambrian to lower Paleozoic metamorphic rocks.

Almost immediately upon his return, he began a comprehensive mapping program of the New York metropolitan region, a program he is still involved with. The mapping concentrated on the surface geology until approximately five years ago when he was given the opportunity to explore the unfilled water tunnels being built by and under the City of New York. The tunnels are drilled into solid rock, 800 feet beneath the surface. As Merguerian puts it, "...a geologist's dream."

Based on his surface mapping, Merguerian had developed a number of hypotheses that he was able to test further through access to the water tunnels. He traced Cameron's Line into New York City, through the East River and up through the West Side of Manhattan. The sequence of exotic rock he identified in Connecticut, known as the Hartland Formation, is also found in New York City. He points out how similar the various rocks, those that are part of the Manhattan Schist and those that are not indigenous, look to the untrained eye. They are very different, the latter originating from an exotic oceanic island sequence of rock.

This part of his work was partially funded by the U.S. Geologic Survey. While exploring the exposed bedrock of the water tunnels he was able to see the sequence characteristic of Cameron's Line in plain view of his scientific vision, confirming the theory he had begun to develop as a graduate student. The experience is similar to that of the detective or historian who gets the opportunity to embark a time machine and verify his or her theories first hand.

One segment of Merguerian's observations in the water tunnel that crossed westward from Queens into Manhattan resulted in some unnerving conclusions. He saw that Cameron's Line was accompanied by a number of relatively fresh, brittle fault lines deep in the bedrock of the City. An outcome of this finding is his ability to state publicly, with disquieting assurance, that the earthquake potential in New York is much higher than had been assumed previously. While his curiosity is much keener concerning the geochemical composition and texture of the rock formations he has observed and documented, he has received the most recognition from the media over his predictions concerning the next New York earthquake.

Merguerian also points out that the water tunnel today is a lost data resource, as it has been cemented over and dedicated to its designated use. He indicates several trays of rocks on his laboratory table as having come from the water tunnels, noting that if he didn't leave his lab for the field again, he would have enough material in those trays for many additional research projects.

Charles Merguerian, from his earliest recollections of his grandmother's rock pile, appears driven to locate and assemble the pieces of the massive jigsaw puzzle that is the subsurface geology of New York City. Just as he was waking up from his geologist's dream of access to a cross-sectional view of rock 800 feet deep, he received a phone call from a colleague about some drill core the City decided to discard. He explains that, consistent with the building code, each time a new construction project is approved, a sample of the subsurface rock must be extruded and examined. The purpose is to insure that the bedrock is strong enough to support the building about to be erected. This drill core is of no scientific interest to the City, other than the evidence it provides regarding the construction project.

After so many years, the City disposes of these samples, which had been stored under the Brooklyn Bridge. Once the building goes up, the opportunity to obtain such samples of the subsurface rock formation is virtually lost forever. Merguerian was able to obtain approximately 1,000 boxes of drill core, each about twenty-five feet long, as well as another thousand boxes of soil samples from around the City.

Merguerian arranged for this collection to be transported to Hofstra University, where today it is stored under the football stadium. He estimates that it is worth multiple millions of dollars, calculated on the basis of $100 per foot to drill it. As a scientific resource it is priceless. Merguerian remembers feeling totally overwhelmed by the potential represented by this material. His first priority was to make it accessible to the scientific community by producing a catalogue, identifying the core and soil, its origin and location on a map grid of New York City. He also had to label each of the 2,000 boxes. He successfully obtained a grant from the Hudson River Foundation for this purpose.

He is currently in the process of computerizing the information on the drill core. He explains that the core is a three-dimensional representation of the subsurface structure and is extremely well suited to computer applications. He has produced a three-dimensional topographic map of the New York area and now is in the process of including the underlying structures.

He returns again to earthquake potential. The drill core confirms even more definitively his earlier conclusions about the potential for seismic activity. It reveals a series of faults crossing under the area. Unlike San Francisco where such activity is expected, the New York infrastructure is not built with even the recognition that earthquakes are possible. Merguerian notes that an earthquake of relatively low magnitude would create massive destruction and chaos.

He emphasizes again that his interest lies in documenting the geology of New York, noting that such a project was all but assumed impossible for lack of data because of inaccessibility to subsurface samples. But Merguerian, his colleagues in the Hofstra geology department and his students, who are exclusively undergraduates, are actively engaged in producing the definitive geological map and history of the City of New York. Despite his exhortations about seismic potential, he seems to believe this to be a long range project.

CAN IT HAPPEN HERE?

Although Charles Merguerian considers the study of earthquakes tangential to his primary professional interests, he is emphatic about his concern that New York is complacent about earthquake potential and preparedness. His mapping of Cameron's Line into New York City and the data provided by the New York drill core and soil sample collection at Hofstra demonstrate that New York City is in far greater jeopardy of significant seismic activity than has been assumed. A strong (magnitude 5) earthquake occurred off the coast of Brooklyn approximately 100 years ago. Smaller quakes have shaken the area during the past ten years.

What is earthquake preparedness? In cities like San Francisco an earthquake mentality develops among the population and municipal agencies. That attitude of expectation and resignation ameliorates much of the panic that otherwise could occur. When major quakes are reported, the rest of the country is impressed by the speed with which normal routines are restored. San Franciscans seem to take it all in stride, as demonstrated in the fall of 1989.

Preparedness is also reflected in the building codes. In the wake of the most recent San Francisco quake, a civil engineer was interviewed and asked how buildings were made earthquake proof. "They're not," he responded. It would be much too expensive even to approach such a standard. Buildings are constructed to protect human life as much as possible. The buildings take the damage, not the people in them.

Charles Merguerian's concern in New York is the absence of an earthquake mentality- the "It can't happen here" attitude. While little can be done about existing structures, Merguerian takes every opportunity to campaign for changes in local codes as they apply to future construction. He notes that even a moderate earthquake in New York City would inflict greater costs in property damage and human life than more serious quakes in San Francisco. Adapting building codes to the new evidence we have would be an effective, low cost way of preventing some of the injuries and deaths resulting from a quake.

The advice remains essentially unheeded, although minor code changes have been made. Buildings, bridges and tunnels continue to be built with little recognition that an earthquake is possible. It is an unfortunate example of the reactive attitude we take when dealing with disaster.