GJQ-003(80)

NATIONAL URANIUM RESOURCE EVALUATION
SCRANTON QUADRANGLE
PENNSYLVANIA, NEW YORK, AND NEW JERSEY

Bendix **Field Engineering Corporation**
Grand Junction Operations

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PREPARED FOR THE U.S. DEPARTMENT OF ENERGY
Assistant Secretary for Resource Applications
Grand Junction Office, Colorado

This report is a result of work performed by Bendix Field Engineering Corporation, Operating Contractor for the U.S. Department of Energy, as part of the National Uranium Resource Evaluation. NURE is a program of the U.S. Department of Energy's Grand Junction, Colorado, Office to acquire and compile geologic and other information with which to assess the magnitude and distribution of uranium resources and to determine areas favorable for the occurrence of uranium in the United States.

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ABSTRACT

Reconnaissance and detailed geologic and radiometric investigations were conducted throughout the Scranton Quadrangle, Pennsylvania, New York, and New Jersey, to evaluate uranium favorability using National Uranium Resource Evaluation criteria. Surface and subsurface studies were augmented by aerial radiometric, hydrogeochemical and stream sediment reconnaissance, and emanometry surveys.

Results of the investigations indicate four environments favorable for uranium deposits: In the Precambrian metamorphic terrain of the Reading Prong, magmatic-hydrothermal and anatectic deposits may occur in the northwestern massif; contact metasomatic deposits may occur in a portion of the southeastern massif. The alluvial-fan environment at the base of the Upper Devonian Catskill Formation appears favorable for deposits in peneconcordant channel controlled sandstones.

Seven environments are considered unfavorable for uranium deposits: the southeastern massif of the Reading Prong, exclusive of that portion denoted as a favorable contact metasomatic environment; the lower Paleozoic sedimentary units; the Beemerville nepheline syenite complex; the Upper Devonian Catskill Formation, exclusive of the favorable basal alluvial-fan facies; Mississippian and Pennsylvanian units; and peat bogs.

Two environments were not evaluated: the Spechty Kopf Formation, because of paucity of exposure and lack of sufficient data; and the Newark Basin, because of cultural density and inadequate subsurface information.

INTRODUCTION

PURPOSE

The Scranton Quadrangle of the National Topographic Map Series (NTMS), scale 1:250,000, encompassing portions of Pennsylvania, New York, and New Jersey (Fig. 1), was evaluated for environments favorable for uranium. The study was conducted by Bendix Field Engineering Corporation (BFEC) for the National Uranium Resource Evaluation (NURE) program, managed by the Grand Junction Office of the U.S. Department of Energy (DOE). Selection of favorable environments was based on the similarity of their geologic characteristics to the NURE recognition criteria described in Mickle and Mathews (eds., 1978). In addition to the application of recognition criteria, genetic modeling was attempted to define more completely uranium favorability of the metamorphic environments.

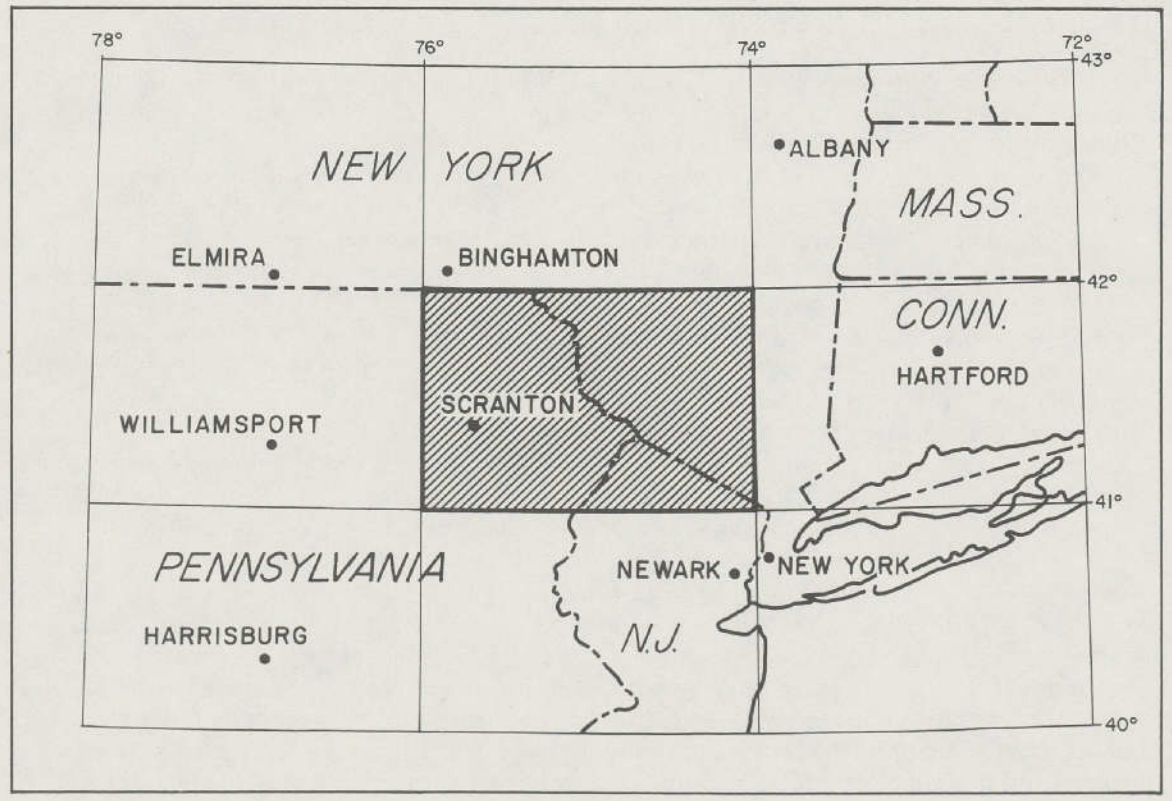

Figure 1. Scranton Quadrangle location map.

ACKNOWLEDGMENTS

The authors acknowledge the following contributions to their work: In the preliminary study phase of the program, the New York and Pennsylvania state geological surveys provided assistance by allowing access to unpublished maps and files. A discussion with Frank Markewicz of the New Jersey Geological Survey provided valuable information on uranium in the Highlands of the Reading Prong.

Richard Wegrzyn, Senior Petrologist of the BFEC Mineralogy and Petrology Laboratory, performed the petrographic analyses, some of which are presented in Appendix E.

SCOPE

Work was divided into three phases: Phase I, preliminary study and work plan (0.8 man year); Phase II, field investigations and data collection (1.25 man-years); and Phase III, data analysis and folio preparation (0.75 man-year). Phase I began on October 1, 1977, and Phase III was completed on May 31, 1979. Additional work in the quadrangle consisted of an aerial radiometric survey and a hydrogeochemical and stream-sediment reconnaissance (HSSR) survey.

PROCEDURES

The field-reconnaissance and data-collection phase of the study was designed to evaluate all the major rock units in the quadrangle. All previously reported uranium occurrences were visited to collect information on the modes of uranium concentration within a given geologic region. In areas having no known occurrences, road reconnaissance traverses were performed to locate those rock units with characteristics favorable for hosting uranium. All uranium concentrations deemed significant were examined in detail (App. C, Uranium-Occurrence Reports). In addition, airborne radiometric survey results were examined and field checked in an attempt to delineate significant anomalies. HSSR data were not available in time for field checking.

Ground evaluation was carried out primarily with the aid of a hand-held scintillometer (Mt. Sopris SC-132). In this folio, radiometric values from scintillometer surveys are given in counts per second (cps) and/or units of radioelement concentration (ur). The most promising occurrences were further evaluated with the aid of a differentiating gamma-ray spectrometer (geoMetrics 400A). Geologic interpretation was based on standard field methods. Grab or chip-type rock and soil samples were collected at selected locations; 195 such samples were sent to the BFEC Mineralogy and Petrology Laboratory for analysis. Occasionally, channel or grid-based sampling was necessary to provide additional information. Also, a small-scale radon gas survey was performed using the Track Etch™ technique.

Evaluation of the quadrangle to the required 1500-m depth was hindered by paucity of detailed subsurface information. Lithologic and gamma-ray logs of 31 deep wells, as well as published stratigraphic studies, were utilized to characterize the various sedimentary rock units at depth. No information exists concerning the subsurface nature of the crystalline and metamorphic rocks in the Scranton Quadrangle.

The stratigraphic terminology in this folio is that used by the New York and Pennsylvania state geological surveys, which is also the terminology commonly used by workers in the field.

GEOLOGIC SETTING

As shown in Figure 2, the quadrangle contains five distinct geologic subdivisions:

- Subdivision 1—Precambrian metamorphic and igneous terrain in the Highlands of the Reading Prong
- Subdivision 2—folded lower Paleozoic rocks of the Wallkill Valley and the Shawangunk Mountains
- Subdivision 3—generally flat-lying Devonian sedimentary rocks of the Allegheny Plateau in the Catskill region of the quadrangle
- Subdivision 4—folded Mississippian and Pennsylvanian rocks of the Northern and Middle Anthracite Basins
- Subdivision 5—a small portion of the Triassic Newark Basin

Figure 3 presents a generalized stratigraphic section for rock units in the quadrangle. The relationships among the many units are frequently complex due to the varied depositional and orogenic histories of the rocks present. Moreover, the quadrangle is covered by a discontinuous mantle of glacial debris. Deposits from both the Wisconsinan and Illinoian glaciations have been identified. Thickness of this horizon varies throughout the quadrangle, and may measure several tens of meters.

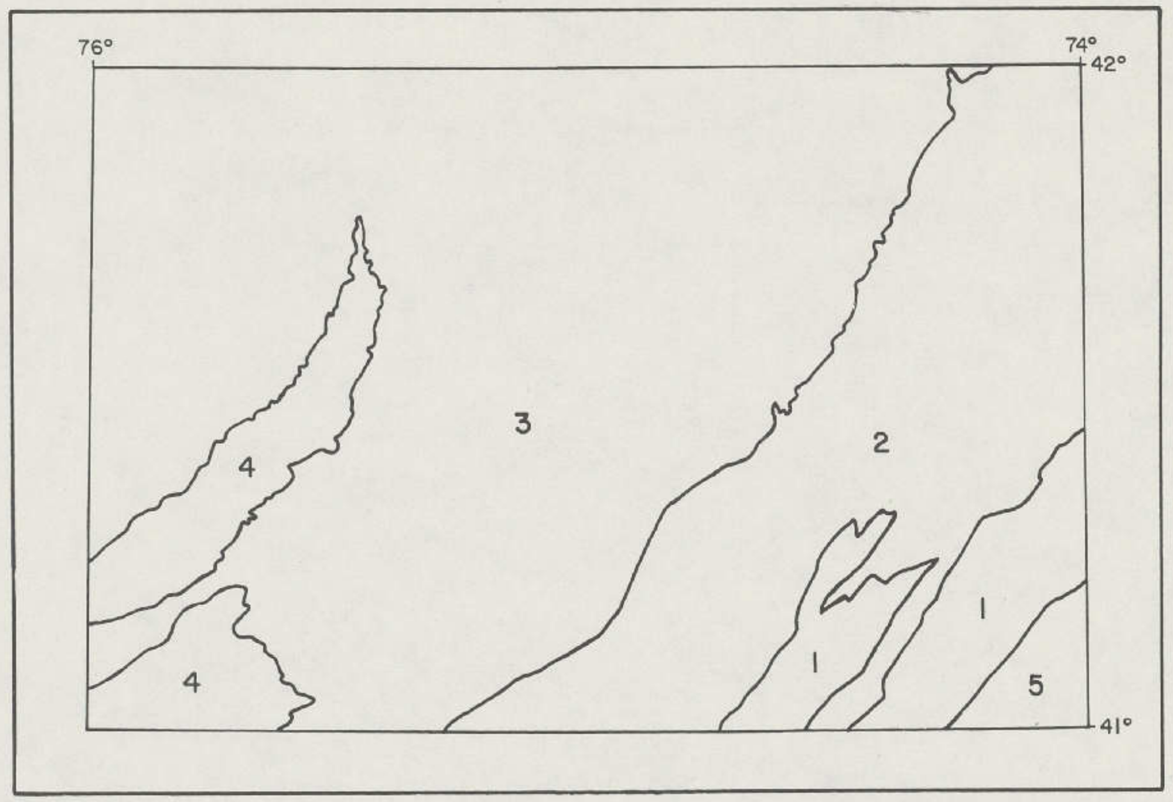

Figure 2. Geologic subdivisions within the Scranton Quadrangle: (1) Reading Prong, (2) Lower Paleozoic rocks, (3) Catskill region, (4) Anthracite Basins, (5) Newark Basin.

Reading Prong

The oldest rocks in the Scranton Quadrangle are the complexly folded metamorphics and intrusives of the Reading Prong. These paragneisses and associated igneous units have undergone intense deformation. Isoclinal folds are common, giving the region its characteristic northeast structural grain. Rubidium-strontium whole-rock dating indicates that the major deformation occurred during the late Precambrian, about 1,150 m.y., with limited igneous activity continuing to 900 m.y. (Helenek and Mose, 1976). The Taconic and Acadian orogenies resulted in extensive brittle deformation and some retrogressive metamorphism of the gneisses; however, there was little modification of the northeast structural grain. Tectonic movement, characterized by vertical uplift, probably continued into the Triassic (Sanders, no date).

Rocks in the Reading Prong are interpreted on the basis of composition and association as largely metavolcanic and metasedimentary. The dominant quartz-plagioclase and biotitic gneisses are interpreted as an original series of andesite flows and tuffs, spilite/keratophyre flows, and graywacke (Helenek, 1971). Intrusive rocks (granites, syenites, and their metamorphic equivalents) were probably derived by partial melting of the paragneisses (Helenek and Mose, 1976; Young, 1978). These intrusives, due to catazonal emplacement, are concordant with the regional northeast structural trend, although late-stage pegmatites and alaskites often display some discordance.

Lower Paleozoic Rocks

Lower Paleozoic rocks (Cambrian through Middle Devonian) in the quadrangle indicate a slow change in depositional environment from a supratidal-shallow neritic shelf to a deeper marine basin. The Lower Cambrian rocks, which lie unconformably upon the Precambrian crystallines of the Reading Prong, comprise a sequence of terrestrial arkoses, orthoquartzite, and limestone. Middle to Upper Ordovician sediments show thick developments of calcarenites and rhythmically bedded graywacke and shale. Fluvial sandstones and conglomerates were deposited in the Early Silurian; upward-fining sequences of terrestrial red beds developed, and, in the Late Silurian, marginal-marine sandstones and subtidal carbonates were formed. Lower and Middle Devonian rocks show interfingerings of basin carbonates, shelf carbonates, and clastics. Extensive folding of these rocks occurred during the Taconic and Acadian orogenies.

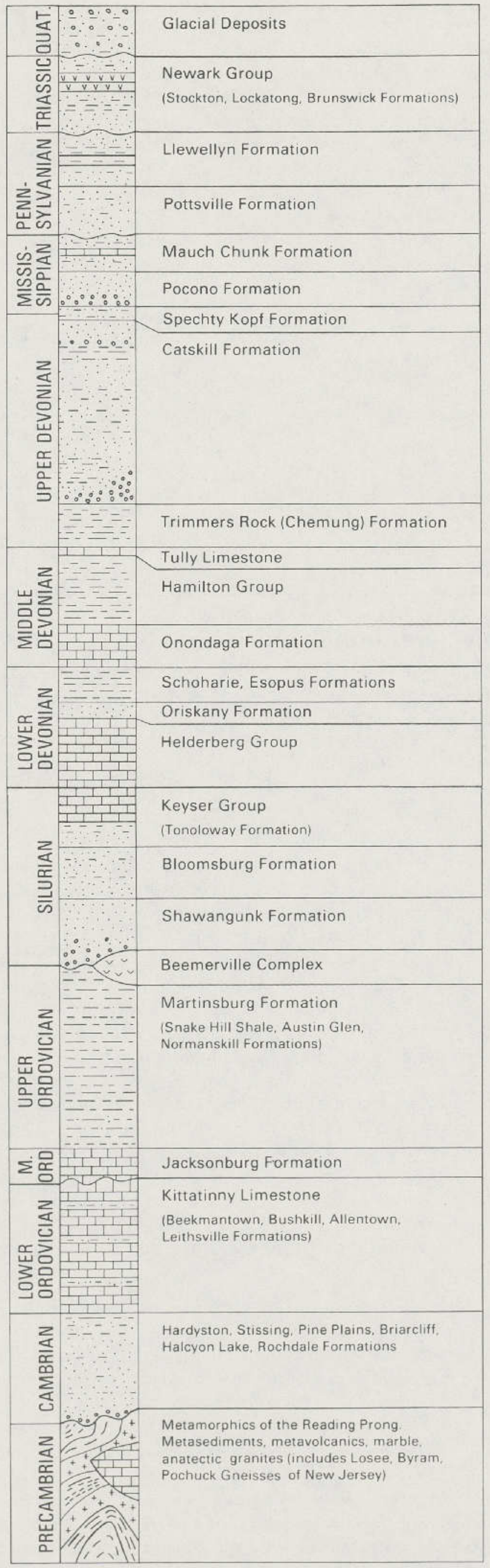

Figure 3. Generalized stratigraphic section.

Great thicknesses of lower Paleozoic sediments are known in the quadrangle. The High Barney No. 1 well near Middletown, New York (Pl. 8), penetrated nearly 2100 m of Cambrian and Ordovician marine strata. The Village of Ellenville No. 1 well intersected over 3000 m of Silurian sandstone and Ordovician shale.

Near Beemerville, New Jersey, a nepheline syenite complex is exposed at the contact of the Silurian Shawangunk sandstone and Ordovician Martinsburg Shale. The complex consists of two stocklike bodies of nepheline syenite and associated dikes and sills of phonolite, tinguaite, lamprophyre, and carbonatite. Potassium-argon and rubidium-strontium dating (Zartman and others, 1967) indicates that intrusion of the syenite occurred during the Late Ordovician, around 435 m.y. Field investigations, however, discovered nepheline syenite dikes that intruded sandstones of Early Silurian age.

Catskill Region

In the Catskill region of the Scranton Quadrangle, Middle and Upper Devonian rocks of the Allegheny Plateau were formed as clastic material from an eastern highland source was deposited onto broad alluvial plains, reworked, and transported westward toward a shallow marine basin (Way, 1972). This distributary runoff created a series of coalescing and prograding deltas. Thickness of Upper Devonian strata in the eastern part of the section reaches 3050 to 4270 m. Rapid thinning of these units occurs in the west, away from the sediment source. The Richards No. 1 well west of Scranton (Pl. 8) penetrated only 1220 m of Upper Devonian sediments. Source materials for the Upper Devonian Catskill Formation* are inferred to be low-rank metamorphic, sedimentary, and minor carbonate rocks (Way, 1972; Sevon and others, 1978). The dominant flow directions and sediment dispersal patterns were to the west and northwest.

Current research (Sevon and others, 1978) suggests the existence of multiple sediment input centers along the eastern margin of the Catskill Formation. These centers are defined by limited areas of maximum sediment thickness, rapid lateral facies change, and distinctive depositional environments. Sediments are coarsest in the vicinity of an input center and quickly become finer away from it. Rapid changes in depositional environment created an extremely complex pattern of lithofacies (Pl. 9).

There has been little postdepositional deformation of the Catskill strata. Some downfolding around the Northern and Middle Anthracite Basins occurred during the late Paleozoic. Elsewhere in the quadrangle, the Upper Devonian units lie flat or undulate only slightly. All the rocks are highly indurated.

Anthracite Basins

Mississippian and Pennsylvanian rocks in the Northern and Middle Anthracite Basins represent a continental succession of fluviatile sandstone, conglomerate, and mudstone. The youngest unit (Llewellyn Formation) contains economic deposits of anthracite coal. The basins are defined by large elongate fold structures, an extension of the Valley and Ridge Province. At least 900 m of Mississippian and Pennsylvanian strata are present in the deepest parts of the basins. Downfolding of the rocks has preserved them from erosion.

Newark Basin

Triassic sediments and basalts of the Newark Basin are found in the southeastern corner of the quadrangle. Crustal rifting and block faulting formed the basin during Late Triassic time. Rapid relief changes along the faulted margins resulted in development of coarse fanglomerates, with a thinning of strata and a decrease in grain size toward the center of the basin. These sandstones and conglomerates commonly are very red in color, with gray shaly layers in the sandstones related to the development of ephemeral lakes. Basalt dikes, sills, and lava flows were emplaced at several periods. According to Sanders (no date), thickness of the Triassic strata in the Newark Basin may reach 7620 m. Gravity studies (Sumner, 1975) suggest a maximum depth for the basin of only 4500 m.

ENVIRONMENTS FAVORABLE FOR URANIUM DEPOSITS

Within the context of this study, a favorable environment is defined as one that could contain uranium deposits aggregating at least 100 tons U_3O_8 in rocks having an average grade not less than 100 ppm U_3O_8. In the Scranton Quadrangle there are three favorable environments within two areas of Precambrian crystalline rocks in the Reading Prong (Pl. 1a, Areas A and B) and one in the sediments of the Upper Devonian Catskill Formation (Pl. 1a, Area C). The environments identified in the Reading Prong are magmatic-hydrothermal (Class 330, Mathews, 1978), anatectic (Class 380, Mathews, 1978), and contact-metasomatic (Class 340, Mathews, 1978); in the Catskill Formation, peneconcordant channel-controlled sandstone (Subclass 243, Austin and D'Andrea, 1978).

Both the Reading Prong and the area underlain by the Catskill Formation are predominantly rural. There are few major population centers and most of the land is used for residential, agricultural, and recreational purposes.

READING PRONG

In the portion of the Reading Prong within the Scranton Quadrangle (Fig. 2) two tectonic blocks have been identified, each characterized by different thermal histories (Young, 1978). Both massifs are composed mainly of folded, high-grade metasediments and igneous rocks of assumed anatectic origin. Syenite is the most common igneous rock type in the northwestern massif, granite the most common in the southeastern. Anomalous uranium concentrations in both blocks appear to be the result of mobilization of uranium from the metasediments during high-grade metamorphism and partial melting. (All the uranium occurrences examined are closely associated with leucocratic igneous rocks.)

In the northwestern massif, a reduction in orogenic pressures (possibly due to uplift) during metamorphism apparently caused the anatectic magmas to boil, releasing large volumes of volatile fluids in which uranium was mobile. Concentration of uranium took place in favorable structural or geochemical traps. In the southeastern massif, pressures appear not to have eased enough to generate a comparable fluid phase, and here the movement of uranium was more restricted. Favorable Area A (Pl. 1a and 1b), having both magmatic hydrothermal and anatectic environments, is located in the northwestern massif; favorable Area B (Pl. 1a and 1c), having a contact-metasomatic environment, is in the southeastern massif.

Thus the three classes of favorable environments identified for the Reading Prong reflect the geologic differences between the two tectonic blocks, the nature of the anatectic fluids generated, and the availability of suitable structural sites for uranium concentration.

Magmatic-Hydrothermal Class

This type environment (Class 330) occurs when uranium, contained in hydrothermal solutions generated during final stages of magmatic differentiation, is deposited in vein systems in brecciated fault or fracture zones.

The magmatic-hydrothermal environment identified in Area A of the quadrangle meets the following recognition criteria:

- Mobile-belt tectonic setting, high-grade metamorphic terrain;
- Elongate fracture zones developed in amphibolite bodies (may also be developed in other metasedimentary units);
- Anatectic igneous rocks in close association with the fractured amphibolite; and
- Presence of hydrothermal mineral deposits within the fracture zone (with or without the dominant presence of magnetite).

Supplementary diagnostic characteristics include:

- Presence of such common uranium-bearing minerals as uraninite, allanite, bastnaesite, monazite, and xenotime; and
- Associated elements such as lanthanum, thorium, iron, sulfur, and phosphorus.

In favorable Area A, the magmatic-hydrothermal environment is typified by the geology around the Miles Standish magnetite mine near Warwick, New York (Occurrence 21, Pl. 2 and 12). Offield (1967) shows the rocks at this site to be an interlayered sequence of quartz-microcline-plagioclase gneiss and amphibolite (Fig. 4). The contacts between these two metasedimentary units are usually well defined, but may occasionally become gradational over a distance of several feet. Thin units of plagioclase alaskite are present in both concordant and discordant relations to the metasediments. Sharp and diffuse contacts exist between the alaskite and the quartz-microcline-plagioclase gneiss; contacts with the amphibolite, where exposed, are sharp. Composition of the amphibolite varies from coarse hornblendite to pyroxene granodiorite gneiss. Petrographic analyses of the major rock types at the Miles Standish Mine are presented in Appendix E (MHI 551, 554, and 555).

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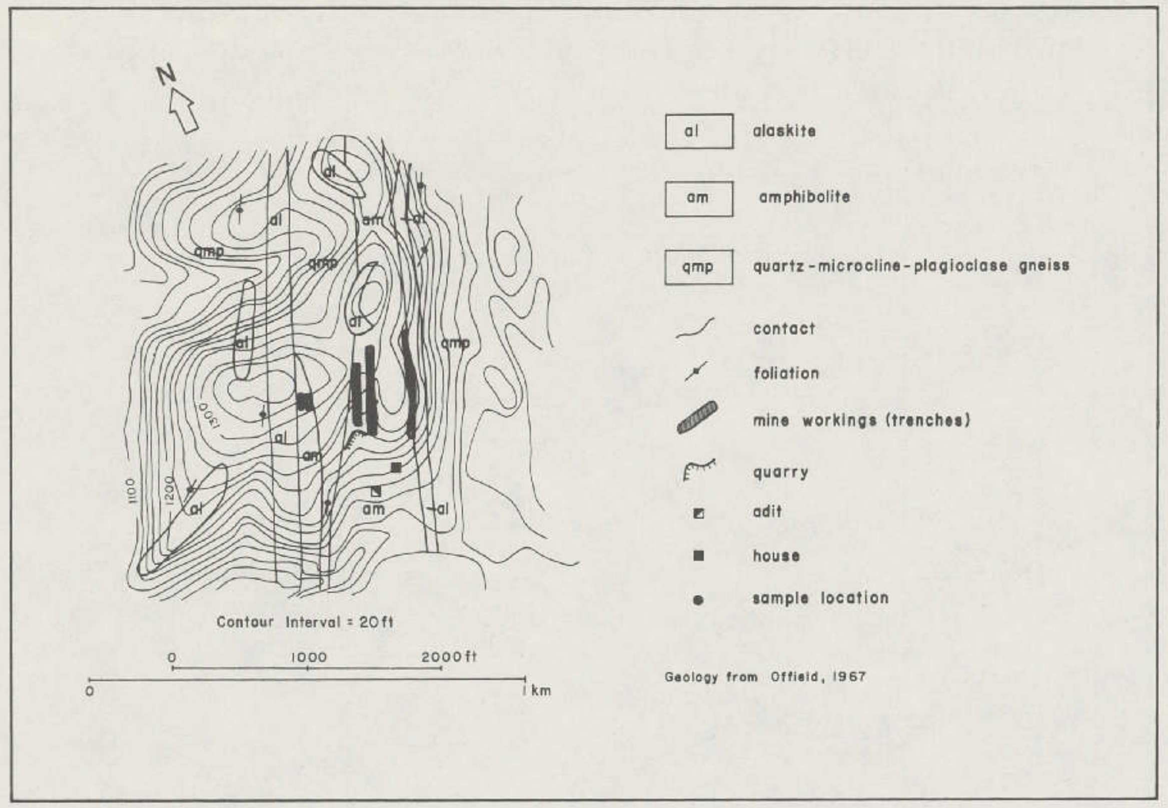
*In New York, Catskill rocks are designated the Catskill Complex, and the individual units are formations; in Pennsylvania, Catskill rocks are designated the Catskill Formation, and their units are members. In this report the term "Catskill Formation" encompasses the entire undifferentiated sequence in both states. Individual units are identified by their local (i.e., state) appellation.



Geology from Offield, 1967

Figure 4. Geology of the Miles Standish Mine area.

Magnetite orebodies are developed as elongate lenses and tabular structures within the amphibolite.These bodies may achieve lengths of over 100 m. Remnants of the now mined out magnetite show it to have been vuggy in appearance, developing large euhedral crystals. It is not known whether the magnetite orebody at the Miles Standish Mine is hydrothermal in origin or whether it was formed earlier in the metamorphic event (Hagner and others, 1963). Between the massive magnetite and the host rock is a discontinuous contact zone enriched in sulfides, rare-earth minerals, apatite, and uraninite.

On the basis of composition and field relations, the thin alaskite units are believed to be the product of partial melting of the paragneisses. Relaxation of orogenic pressure during metamorphism caused the formation of an extensive fluid phase in the anatectic magma (alaskite precursor). Tension fractures in the amphibolite were produced simultaneously. A fluid enriched in uranium, thorium, rare earths, and sulfides migrated into the fracture zones. Apatite, uraninite, rare-earth minerals, and sulfides were deposited adjacent to the magnetite ore, probably under conditions of decreased oxygen fugacity. In addition to the uranium deposited in the contact zone, some uranium migrated into the country rock, producing small, localized metasomatic concentrations.

If the magnetite predated the uranium, it would have provided a geochemical as well as a structural trap for the hydrothermal minerals. Oxygen fugacity in the immediate vicinity of the ore would have been low, promoting the precipitation of uraninite. Evidence that the magnetite was not part of the hydrothermal suite is that there is no trace of uranium within the ore, whereas all the minerals in the contact zone are closely intergrown. The free-growing, euhedral nature of the magnetite may be due to recrystallization in fracture spaces during the hydrothermal event.

The distribution of radioactivity over the mine property is uneven. Radiometric background levels in the alaskite and the quartz-microcline-plagioclase gneiss, measured with a scintillometer, averaged 110 to 120 cps. The coarse-grained amphibolite at the margins of the magnetite orebody gave frequent readings up to 2,500 cps (550 ur), and the contact rock containing abundant sulfides and rare-earth minerals gave readings in excess of 3,000 cps (700 ur). A small localized radiometric high in the amphibolite (pyroxene granodiorite) zone immediately west of the main ore trench read 12,000 cps (2,925 ur).

Gamma-ray spectrometer analyses indicated 100 to 650 ppm equivalent uranium along the ore-amphibolite contact, and up to 2,500 ppm equivalent uranium in the amphibolite. Thorium-to-uranium ratios, as determined by spectrometer analysis, vary across the ore zone. On the west (hanging) wall of the magnetite orebody, the thorium-to-uranium ratio averages 0.15, whereas on the east wall the ratio varies between 5 and 7. These different ratios probably reflect the relative enrichment of uranium-bearing minerals on the west wall. Trace- and minor-element analyses for all samples collected are given in Appendix B.

Geologically related to the Miles Standish Mine are the Raynor and Centennial Mines (Occurrences 22 and 24, Pl. 2 and 12). All are abandoned iron workings containing anomalous amounts of uranium, thorium, and rare-earth minerals. All three are situated along a northwest-trending magnetic high that underlies Warwick and Taylor Mountains (Pl. 12).

Mapping throughout much of the Reading Prong is on such a large scale that it is impossible to delineate all those amphibolite bodies that have characteristics favorable for hosting magmatic-hydrothermal uranium deposits. However, the area underlain by favorable amphibolites in the Goshen–Greenwood Lake Area (Offield, 1967) can be calculated (Pl. 1b). If an even distribution of amphibolite is assumed across Area A, then there is 0.06 km^2 of favorable host rock for every square kilometer of Area A. The total extent of Area A is 475 km^2.

Anatectic Class

Uranium contained in sedimentary and igneous rocks may be liberated by high-grade metamorphic processes and become concentrated in anatectically derived fluids. Crystallization from these fluids produces uranium occurrences of the anatectic class (Class 380).

The anatectic environment identified in Area A of the Scranton Quadrangle meets the following recognition criteria:

- Mobile-belt tectonic setting, high-grade metamorphic terrain;
- Ferromagnesian zones adjacent to the anatectites showing retrogressive metamorphism;
- Catazonal emplacement of anatectites; and
- High SiO_2, elevated Na_2O, K_2O, variable thorium-to-uranium ratios.

Supplementary diagnostic criteria include:

- Impermeable contacts between metasediments and anatectically derived alaskites;
- Garnet, biotite, and monazite developed in anomalous size and abundance along the contact;
- Associated elements such as thorium, lanthanum, yttrium, and titanium; and
- Radioactive-element enrichment along the contact zone above levels found in the anatectites or metasediments.

The environment favorable for anatectic uranium deposits is displayed at Rock Hill, Warwick, New York (Occurrence 20, Pl. 2 and 12). Mapping across this hill by Offield (1967) shows an interlayering of graphitic quartz-feldspar gneiss, hornblende-feldspar gneiss, pyroxenite, and coarse-grained alaskite (Fig. 5). Across a limited area of exposure these units all strike parallel to the regional northeast trend. The contact between alaskite and quartz-feldspar gneiss is exposed at the top of the hill, and is marked by a mineralized zone varying from 0.3 to 3 m in width and over 100 m in length. The dominant minerals present in the contact zone are biotite (50%), plagioclase (30%), monazite (10%), and garnet (10%). The texture of the rock is xenoblastic, with many of the minerals occurring in segregations. Grain sizes range from very coarse for biotite, feldspar, and garnet to fine for monazite and the minor constituents. Petrographic descriptions of the contact rock (MHI 628) are given in Appendix E.

Uranium, thorium, and the rare-earth elements are enriched in the contact zone. Although the average scintillometer background level for the hill is 110 cps, readings in the contact zone are greater than 500 cps (75 ur) throughout, with local highs to 20,000 cps (5,000 ur). Gamma ray spectrometer field measurements show 100 to 1,000 ppm equivalent uranium and 100 to 10,000 ppm equivalent thorium in the contact zone. The thorium-to-uranium ratio ranges from 6 to 19; the highest values occur in the more mineralized sections. High thorium and rare earth abundances reflect the large amount of monazite. The alaskite and the quartz-feldspar gneiss on either side of the contact showed only 2 to 3 ppm U_3O_8.

Mineralization at Rock Hill was probably contemporaneous with that at the Miles Standish Mine. Alaskite bodies at the two sites appear to be identical on the basis of mapping and field examination. Release of confining pressure on the anatectically derived magma generated fluids enriched in radioactive and rare-earth elements. Because the contact of the quartz-feldspar gneiss was an impermeable barrier to the lateral migration of these fluids, uranium, thorium, and the rare-earth elements continued to be concentrated until crystallization occurred. It is not known which metasedimentary layers are the most favorable for forming such impermeable barriers. As mentioned in the previous section, amphibolites are most likely to fracture during pressure relaxation, giving rise to different types of occurrences. Metasedimentary gneisses have greater resistance to fracturing and would thus be more likely to provide the necessary "dam" in this anatectic environment.

The lateral extent of the contact zone on Rock Hill is unknown because of the glacial cover on the flanks of the hill. A Track Etch™ radon gas survey designed to trace the lateral extent of the mineralized contact zone had equivocal results (Pl. 13). High radon levels found in the soil gas south of the hill indicate the continuation of anomalous radioactivity. However, no linear patterns indicative of a buried, mineralized contact zone could be delineated, probably due to lateral diffusion of radon in the soil.

There are indications in Area A that the Franklin Marble may also act as an impermeable barrier to fluids released during partial melting. Mt. Adam and Mt. Eve, two hills west of Warwick, New York, are composed primarily of biotite granite and have been mapped as intruding the Franklin Marble (Offield, 1967). In outcrop the granite is very similar in appearance to leucocratic igneous rocks elsewhere in Area A. One distinctive feature is the presence of small purple fluorite crystals, commonly associated with magnetite. Although no anomalous concentrations of uranium were discovered during the course of field work, HSSR sampling showed very high uranium values in ground water south of the hills. Local historical accounts mention the presence of arsenopyrite in the immediate vicinity of the hills, and a local farmer told of collecting large tourmaline crystals on the flanks of Mt. Adam. It appears that some hydrothermal activity accompanied the intrusion of the biotite granite; uranium may have been concentrated against the contact with the marble.

From mapping by Offield (1967), it is possible to obtain a value for the length of potentially favorable contacts between leucocratic rocks of anatectic origin and metasediments, exclusive of amphibolites (Pl. 1b). If an even distribution of these rock types is assumed, then there are 1.4 km of favorable contact for every square kilometer of Area A. The total extent of Area A is 475 km^2.

Contact-Metasomatic Class

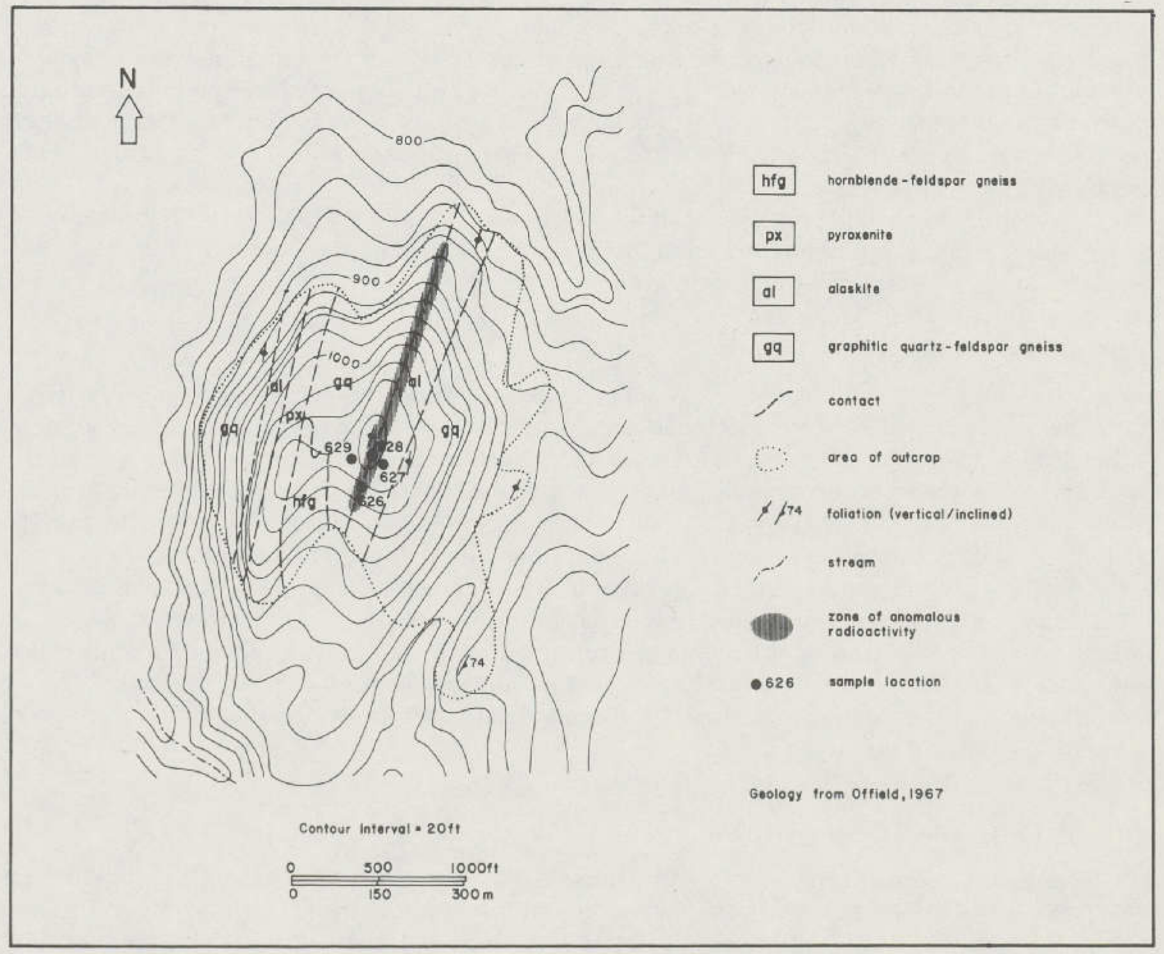
Contact-metasomatic uranium occurrences (Class 340) are fine disseminations that develop during the late stages of magmatic evolution by replacement reactions between uraniferous magmatic emanations and suitable country rocks. Mafic and calcareous hosts, as well as concentrations of mafic minerals within the host rocks, are ideal sites for uranium deposition by metasomatizing fluids.

The contact-metasomatic environment identified in Area B (Pl. 1a and 1c) of the Scranton Quadrangle meets the following recognition criteria:

- Mobile-belt tectonic setting, high-grade metamorphic terrain;
- Tight folding of metasediments and concordant intrusion of anatectic igneous rocks; and
- Variable lithology.

Supplementary diagnostic characteristics include:

- High confining pressures limiting release of abundant volatiles, and thus limiting the distance over which uranium could migrate; and
- Associated elements such as iron, lanthanum, yttrium, and thorium.



Geology from Offield, 1967

Figure 5. Geology of Rock Hill.

The only type of uranium occurrences expected in the southeastern massif of the Reading Prong are small metasomatic concentrations at the contact between leucocratic igneous rocks and metasediments (including amphibolite). Numerous occurrences have been found. In all cases the uranium level in the two rock types is low but increases immediately around the contact (a hundredfold increase is not uncommon). In outcrop the enriched zone is usually less than 10 m^2 in area.

The southeastern massif is characterized by a lesser development of hydrothermal assemblages and smaller uranium concentrations. Rocks of this block appear to have been under higher pressure during anatexis than those to the northwest. Although partial melting and alaskite emplacement occurred, an extensive fluid phase was not produced. Uranium could not be liberated from large rock volumes and, in the absence of a pervasive fluid phase, could migrate only over restricted distances. Also, under higher confining pressures large fractures would be less likely to occur in amphibolites.

An investigation of the magnetite ore at the Scott Mine near Sterling Lake, New York, by Hagner and others (1963) showed that the iron ore formed by metasomatic diffusion of iron out of an amphibolite rather than by hydrothermal emplacement. Most of the other magnetite bodies in this tectonic block appear to be of this type. Formation of the magnetite orebodies may have predated the anatectic event.

In only one area of this massif, around Monroe, New York (Occurrences 17 and 18, Pl. 2), does contact metasomatism appear to have been a sufficient concentrating mechanism to be considered favorable for the formation of uranium deposits. In this area (Area B, Pl. 1a and 1c) a greater abundance of uranium is indicated.

Two contact-metasomatic uranium occurrences have been found at magnetite mines in the Monroe area. At the Clove Mine (Occurrence 17, Pl. 2) uranium and lanthanum are enriched within a coarse pyribolite along the walls of a prospect trench (55 ppm U_3O_8; 1,000 ppm La). Over an area of several hundred square meters around the mine workings, radiometric readings consistently greater than twice background are found. Hornblende granite is exposed within 300 m of the mine and may have been responsible for concentrating iron and uranium at this site. Excavations at the Mombasha Mine (Occurrence 18, Pl. 2), less than 3 km south-southeast of the Clove Mine, reveal an isoclinally folded magnetite orebody within an amphibolite. The host amphibolite shows only 1.5 ppm U_3O_8, whereas a granite in contact with the northern margin of the orebody shows enrichment to 85 ppm U_3O_8. Elsewhere in the Monroe area alaskitic rocks show an internal enrichment of uranium of 10 ppm or greater.

HSSR sampling at three sites in the Monroe region revealed high uranium levels in both stream and ground water. Regression analysis identified high uranium anomalies in both ground water and stream sediments. Such intense and persistent anomalies were not found elsewhere in the southeastern massif. Uranium may be present in the Monroe area in greater abundance than in the rest of the block. If so, there is a possibility that the contact metasomatic process formed a concentration of uranium large enough to be classed as a deposit.

Measurements based on mapping in the Monroe area (Jaffe and Jaffe, 1973) indicate that there are 1.5 km of potentially favorable contacts for every square kilometer of Precambrian terrain. The total extent of Area B is 85 km^2.

Alternative Uranium-Concentration Model

An alternative hypothesis for uranium concentration in the Reading Prong has been proposed by Grauch (1977). He concluded, based on an examination of the Camp Smith–Phillips Mine area just east of the Scranton Quadrangle, that premetamorphic concentration of uranium took place in a marine, volcanogenic environment. Associated with this period of concentration was the emplacement of a massive sulfide deposit. Some redistribution of uranium is thought to have occurred during metamorphism. To date no sulfide deposits of comparable size have been found in the Scranton Quadrangle. We do not believe that enough information exists at present to make a statement about premetamorphic concentration of uranium in the rocks of the Reading Prong. All evidence points to uranium concentration as a result of a high-grade metamorphism and anatexis. Descriptions of the geology of the Camp Smith–Phillips Mine area (Grauch, 1977; Klemic and others, 1959a) indicate that the concentration of uranium is compatible with a metamorphic model.

BASAL CATSKILL FORMATION

The basal, alluvial-fan facies of the Catskill Formation (Pl. 1a, Area C) is considered favorable for uranium deposits in peneconcordant, channel-controlled sandstones (Subclass 243). This environment comprises essentially stratabound deposits that do not normally exhibit a continuous sharp boundary between altered and unaltered zones, but appear to have formed in locally reduced areas (pods or patches) in otherwise oxidized sandstones. They typically occur in discrete, easily recognized channels scoured into underlying strata.

The peneconcordant, channel-controlled sandstone environment identified in Area C meets the following recognition criteria:

- Platform tectonic setting (Allegheny Plateau);
- Major environmental break with underlying marine strata;
- Extensive development of channels in an alluvial-fan environment;
- Coarse-grained, channel-filling sandstones, conglomerate layers and lenses (channel bars);
- Braided-stream environment with high-bedload channels;
- Long, sinuous channel features;
- Postdepositional oxidation/reduction changes, characterized by red and gray coloration of units;
- Secondary uranium minerals, most of the uranium apparently in combination with organics; and
- Associated elements such as copper, arsenic, vanadium, and sulfur.

Supplementary diagnostic characteristics include:

- Abundant organic debris; and
- Impermeable mudstones separating upward-fining cycles.

Along the eastern margin of the Upper Devonian Catskill Formation in Pennsylvania and New York, rocks of the basal alluvial-fan facies crop out in a 15-km wide section (Pl. 1a, Area C). Mapping by the New York geological survey places this facies within the lower and upper Walton units of the Catskill; comparable units have not been delineated in Pennsylvania because of different mapping criteria. Figure 6 shows the differences in nomenclature between the two states.

The rocks in Area C are assumed to lie close to the original sediment source. Streams and rivers discharging from the highland source region created a complex pattern of coalescing alluvial fans, which display such characteristic features of an alluvial-fan environment (Bull, 1972) as:

- Thick, cyclical, upward-fining sequences of coarse sandstone and mudstone, the sandstones displaying well-developed cross-bedding;
- Discontinuous units that appear to be coarse-grained debris flows;
- Sheetlike nature of the main sedimentary units;
- Cut-and-fill structures, channel scours, coarse conglomerate channel bars; and
- Intersecting channels suggestive of a braided-stream environment.

In the Glen Wild area of southeastern New York, a series of rocks characteristic of a braided-stream environment contain highly anomalous concentrations of uranium (Baillieul and Indelicato, 1978). The most distinctive feature of these rocks (Occurrences 1 to 9, Pl. 2 and 12), is a repetition of upward-fining cycles (Fig. 7). In each cycle, which may vary from 3 m to over 15 m in thickness, gray, medium- to very coarse-grained sandstone grades vertically to red mudstone. The contact at each cycle boundary is erosional. Extensive development of conglomerate is limited, although thin pebble layers are common at the base of each cycle. Paleocurrent measurements at 45° class intervals indicate a general northwest direction of flow that agrees with the regional sediment dispersal pattern (L. Roe, BFEC, oral comm., 1978). Channels are commonly seen to overlap or intersect, suggesting a continual shifting of the original streams. It is impossible to follow a single rock layer laterally for more than a few hundred meters due to the intersecting nature of the channel features.

Fine, silty layers overlying conglomerate lenses indicate that depositional energies varied rapidly. Some conglomerate horizons even appear to have been deposited as debris flows. In the sandstone portions of each depositional cycle, trough cross-bedding is ubiquitous. As grain size decreases upward, cross-bedding becomes less prominent. The mudstone in each cycle is structureless except for occasional thin laminae of shale.

The primary clastic constituents of the rocks around Glen Wild are quartz and metamorphic rock fragments. (See App. E for detailed thin-section analyses.) Feldspar contents below 8% place the rocks in the litharenite and feldspathic litharenite classes of Folk (1968). Chlorite is abundant as both a detrital and an authigenic component of the rocks. Hematite is present as small interstitial grains, as a coating on large clastics, and as a cement. A substantial matrix is present in most of the samples collected, giving the rocks an overall poorly sorted character. Carbonate cement may amount to as much as 10% of a rock but is usually much less; silica and barite cements are minor. Organic material is common in most of the rocks, usually in the form of small disseminated plant fragments, although larger pieces are found. In thin section, sulfide minerals can be seen in direct association with organic material.

Color changes in the rocks are probably related to postdepositional ground-water flow. The coarser portions of each cycle tend to be gray, although some red sandstones do occur. Color boundaries are gradational and are seen occasionally to cut across bedding. The mudstone is almost always red except for the top few centimeters in a cycle where it contacts gray, reduced sandstone.

Additional coarse conglomeratic units, indicative of a braided-stream alluvial-fan environment, are found in the area west of Port Jervis, New York. The Lackawaxen Formation (probably equivalent to the upper Walton), which contains three distinct conglomeratic horizons, is exposed near Shohola, New York. Rocks in this unit are distinctly arkosic (15% to 20% feldspar) and are thus related to a different suite of source rocks than the Glen Wild units (W. D. Sevon, Pennsylvania Geological Survey, oral comm., 1978). A low-grade airborne radiometric anomaly was observed for this area on plots of equivalent uranium for the lower Walton (Pl. 3); however, no uranium concentrations have yet been found within the Lackawaxen.

Most of the uranium occurrences in the Glen Wild area (Occurrences 1 to 9, Pl. 2 and 12) are associated with organic material accumulated in well-developed channels within a coarse sandstone horizon. These channels are frequently marked by coarse conglomerate-filled scours and conglomerate lenses (channel bars). In some locations channel development is restricted to a well-defined position in the upward-fining cycles. Elsewhere both sandstone

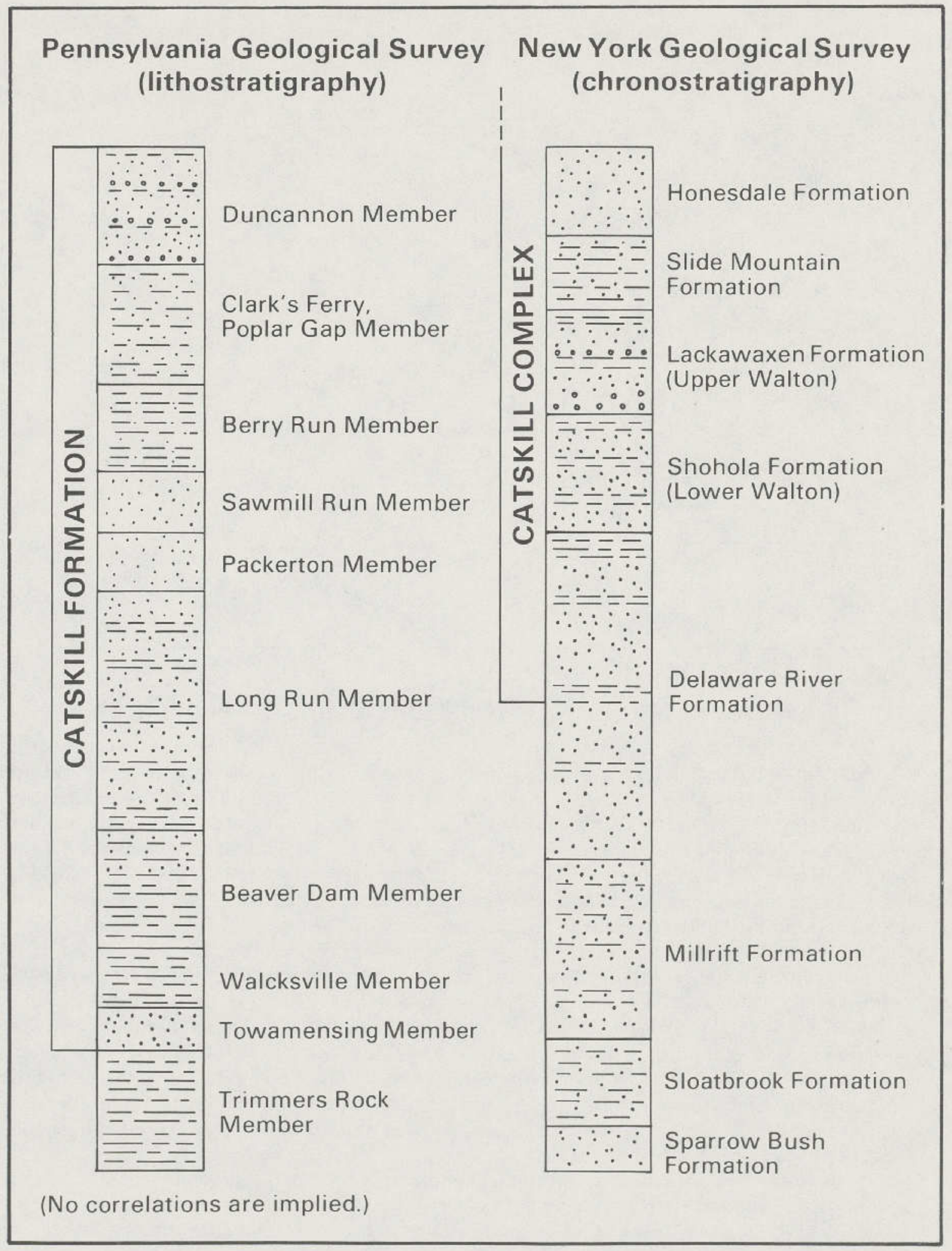


Figure 6. Two stratigraphic nomenclature systems used for Upper Devonian rocks in the Scranton Quadrangle.

and mudstone units are truncated by numerous intersecting channels. Within any channel there may be thin layers of silty, organic-rich material, commonly associated with conglomerate-lens features.

The color of the channeled sandstones varies from gray to red, controlled by the relative abundances of hematite and chlorite in the rocks. At Occurrence 1 all the sandstone horizons are uniformly gray; at Occurrence 3 red is the predominant color except for a lens-shaped zone of gray (reduced) coloration around an organic accumulation. Where exposed, the boundary between the two colors is gradational and frequently cuts across bedding.

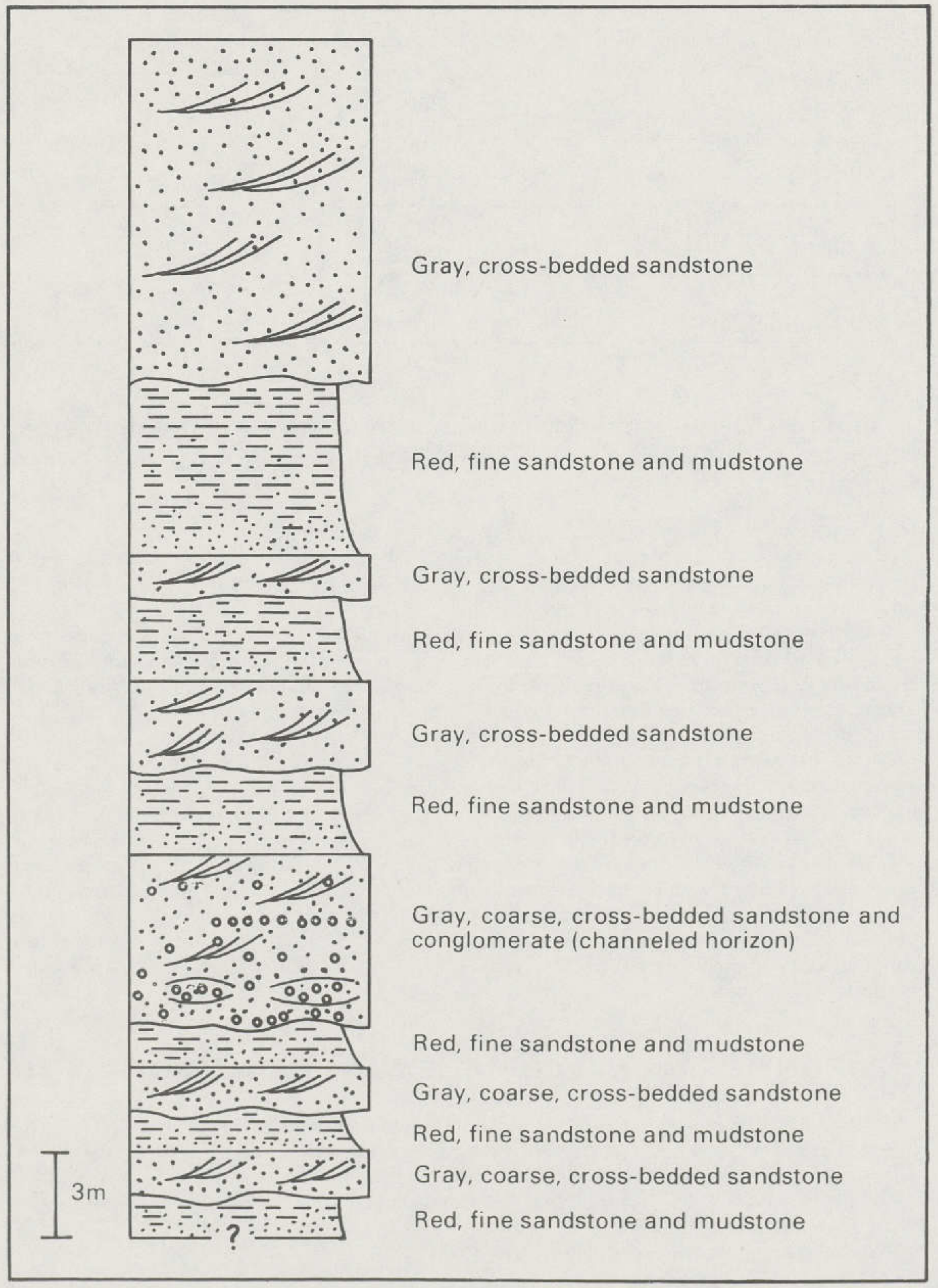


Figure 7. **Approximate stratigraphic section of lower Catskill Formation, Glen Wild, Occurrence 1.**

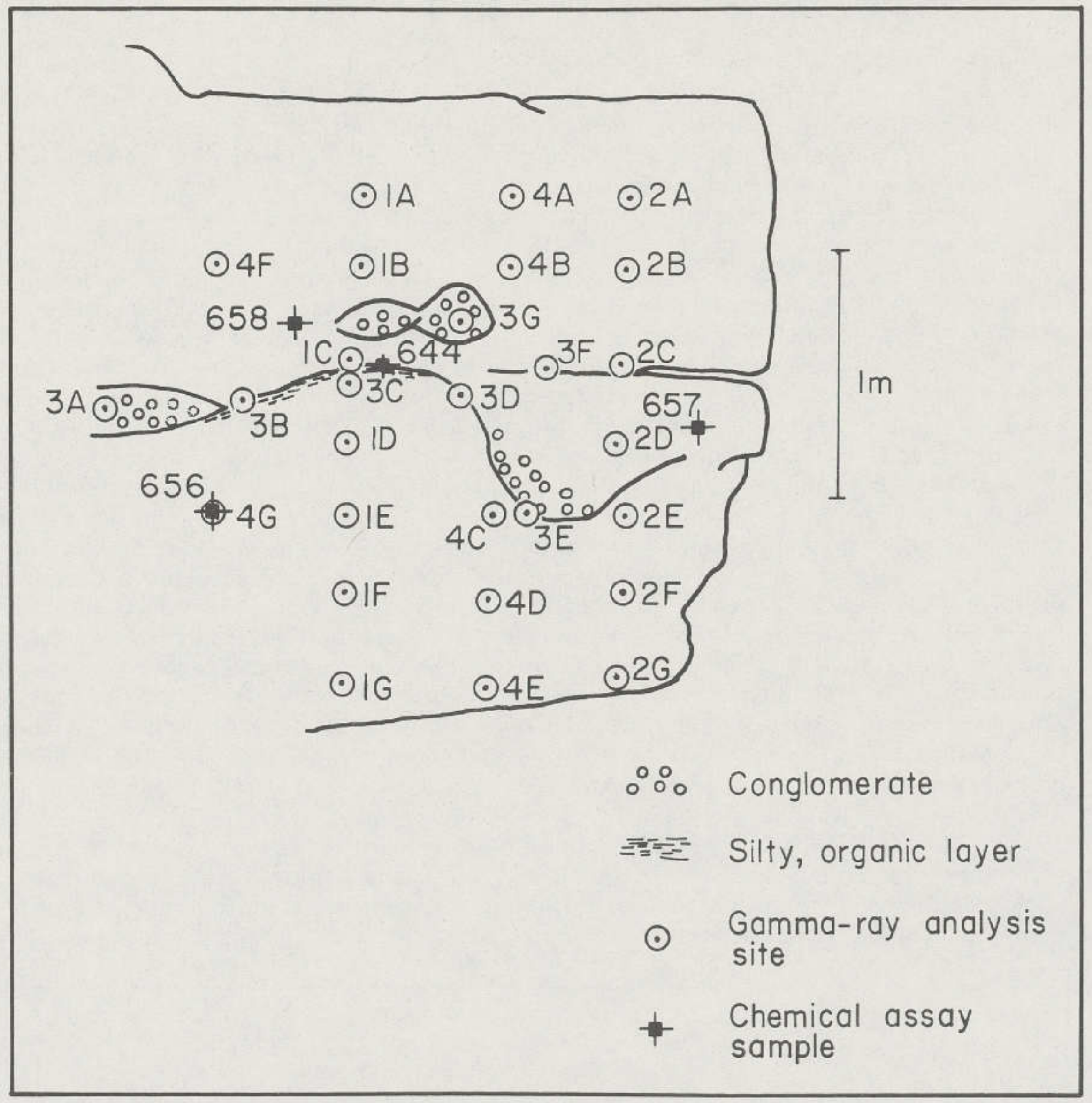


Figure 8. **Vertical section of part of the main channel at Occurrence 1, showing gamma-ray and chemical-assay sites.**

Several of the occurrences in the Glen Wild area show significant concentrations of uranium. At Occurrence 1 a concentration of 2,760 ppm U_3O_8 was reported from an organic rich band overlying a conglomerate lens (MHI 644). A sample of conglomerate showed about 50 ppm U_3O_8 (MHI 659), and the coarse sandstone contained 70 to 9,980 ppm U_3O_8 (MHI 649 and 669). At Occurrence 3 a sample of organic-rich siltstone displaying visible malachite assayed at 1,530 ppm U_3O_8 (MHI 639). At Occurrence 4 coarse sandstone with plentiful organics showed a concentration of 1,060 ppm U_3O_8 (MHI 642). From the same site a similar sandstone sample, but without visible organics, assayed at 3 ppm U_3O_8 (MHI 643).

At Occurrence 1 anomalous scintillometer readings (500 cps, 75 ur) were found along a 100-m by 8-m cliff face. Within this outcrop several coarse conglomerate-lens features and associated fine, organic-rich layers displayed even greater radioactivity. One clustering of lenses occupying a 6-m^2 section of the rock face gave readings in excess of 20,000 cps (5,000 ur). Contouring of radiometric values shows the radioactive zones to be pod shaped and not directly related to any specific sedimentary structure. A gamma-ray spectrometer analysis, performed at sites around the main channel section at Occurrence 1 (Fig. 8 and Table 1), indicated considerable concentrations of uranium. Similar lens- and pod-shaped radioactive features were seen at Occurrence 3 as small radiometric highs (1 to 3 m^2) around conglomerate channel fills (Fig. 9).

The channeled-sandstone unit is not mineralized everywhere in the Glen Wild area. Anomalous radioactivity in this unit has been traced south from Occurrence 1 for over 1 km along the west side of the Neversink River. On the east side of the river only sporadic mineralization has been observed for conglomerate-filled channels.

Several secondary uranium minerals have been identified in samples from the channeled horizon. Included are uranophane, brannerite (which may be detrital in origin), kasolite, and saleeite. These minerals comprise only a minor portion of any rock sample; most of the uranium appears to be associated with organics. No uranium minerals could be identified in organic-rich samples from Occurrences 3 and 4, which assayed over 1,000 ppm U_3O_8. It is interesting to note, however, that at Occurrence 8 two samples of organic-rich fine gray sandstone, taken approximately 10 m apart, contained vastly different uranium concentrations (7 ppm U_3O_8 for sample MHI 038 and 1,500 ppm U_3O_8 for sample MHI 036). This difference suggests that uranium mineralization of the rocks was not a uniform process.

TABLE 1. RESULTS OF A GAMMA-RAY SPECTROMETER SURVEY AT OCCURRENCE 1 (SEE FIGURE 8 FOR SAMPLE LOCATIONS)

Station No.	Total Count*	K (cps)	U (cps)	Th (cps)	eU (ppm)
1A	1,800	64	64	1	190
1B	2,250	113	117	4	349
1C	6,500	234	267	7	804
1D	11,000	425	475	13	1,430
1E	4,500	118	120	3	361
1F	1,000	48	36	2	104
1G	1,000	35	30	3	84
2A	1,800	69	71	2	212
2B	2,500	99	107	4	318
2C	5,000	454	512	13	1,544
2D	10,000	497	582	12	1,761
2E	2,500	177	193	5	581
2F	950	43	43	2	126
2G	950	36	34	2	98
3A	16,000	620	723	22	2,172
3B	12,500	526	610	18	1,834
3C	20,000	1,111	1,313	48	3,928
3D	14,500	674	756	23	2,272
3E	4,700	160	189	5	568
3F	11,000	616	731	20	2,201
3G	20,000	1,205	1,355	43	4,070
4A	2,000	80	85	3	253
4B	3,000	168	175	5	526
4C	4,250	174	197	5	593
4D	1,300	50	43	2	126
4E	1,000	39	36	2	105
4F	2,000	79	75	2	225
4G	5,000	218	236	2	717
**BG	117	9.5	2	1.6	--

* Total counts by scintillometer, all others by gamma spectrometer.

** Averaged background

Most of the channel-type occurrences show an enrichment of copper as well as uranium, even though copper minerals may not be visible in outcrop. Copper minerals identified by thin-section analysis are chalcopyrite, covellite, cuprite, and malachite. These were all interpreted to be of secondary origin. Figure 10 illustrates a significant positive correlation between copper and uranium for selected sites in the Glen Wild area. Most samples from the channeled sandstone and conglomerate associations plot along a straight line. Discrepancies occur where recent solution and reprecipitation of uranium have occurred or where the rock is of a finer grained and organic-rich nature. Samples from Occurrence 3 display a different trend from the other samples due to a greater abundance of copper. Whether the uranium and copper entered the rocks in this region at the same time or whether the observed correlation reflects more recent redeposition is not known.

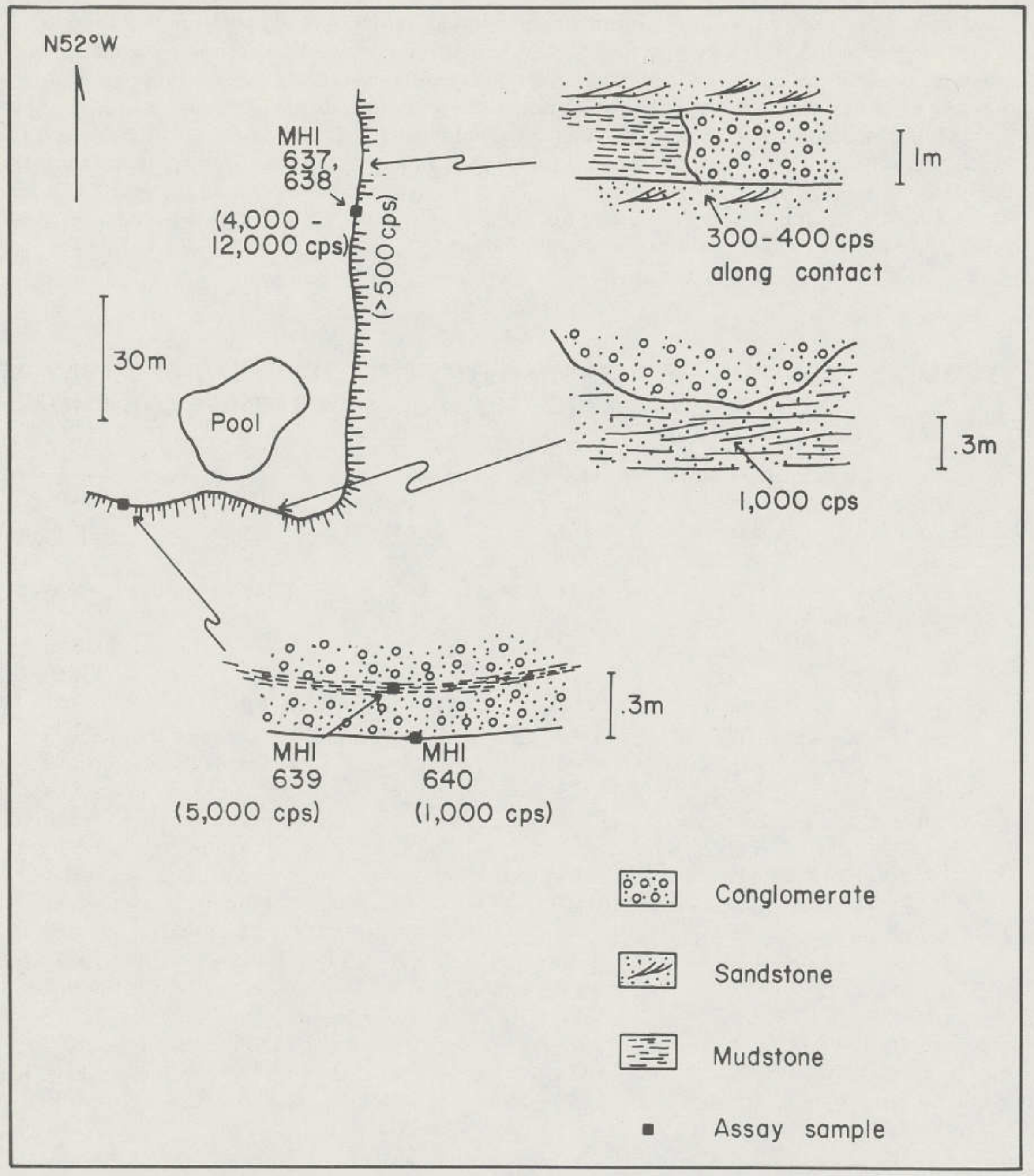


Figure 9. Radiometric values and sample locations for channeled sandstone at Occurrence 3.

Three additional occurrences of uranium in the Glen Wild area (Occurrences 5, 6, and 7) are characterized by similar host-rock type, stratigraphic position, and patterns of radioactivity that are distinct from the channel type previously described. The rock at these localities is a coarse, poorly sorted sandstone (feldspathic litharenite) that displays well-developed cross bedding but no channel features. Conglomerate horizons are absent. The sandstone tends to have an overall pinkish-gray color due to minor hematite, which is visible in hand specimen. Red mudstone apparently underlies the sandstone but is exposed only locally. Organic debris is very minor or completely missing in both outcrop and hand sample. When the regional dip of strata is compared with the location of outcrops, this sandstone horizon appears to lie stratigraphically above the channeled and conglomerate units. The sandstone may represent a flood-plain environment that developed marginally to one of the main channels.

Anomalous radiometric values were measured over several hundred square meters around Occurrences 5 and 6. At Occurrence 5 a highly radioactive zone 5 m^2 in size was discovered on the northern shoulder of Taylor Road (Pl. 12). A sample of the sandstone found beneath a 0.2-m soil layer assayed 3,000 ppm U_3O_8. Uranium minerals identified from this site include brannerite, metatorbernite, saleeite, autunite, and possibly uranospathite and troegerite. Chalcopyrite, cuprite, and malachite were identified as secondary copper species. Mineralized rocks not obscured by soil cover were seen at Occurrences 6 and 7. Sporadic radiometric anomalies were found along ledges of sandstone at each of these sites. However, no structural or chemical controls of mineral enrichment could be observed. Uranium assays of 100 to 3,000 ppm U_3O_8 were obtained from selected samples (MHI 033, 034, 035, and 641). Anomalous copper values were also recorded but did not show the good correlation with uranium observed from the channeled horizon.

Anomalous uranium concentrations in the Glen Wild area are also observed along the contacts between red mudstone and overlying gray sandstone. Significant enrichment, however, is found only beneath major mineralized zones in the sandstone, suggesting derivation from a common source. The best example of this contact-type occurrence is found below the mineralized channel zone at Occurrence 1. Here the contact with mudstone lies about 8 m beneath the conglomeratic sandstone horizon. Elevated radiometric values are found along this contact for a distance of 200 m. Uranium enrichment appears to be confined to a zone 0.4 m wide on either side of the contact. Samples from this zone have assayed to 500 ppm U_3O_8. Only limited organic debris is seen in either the sandstone or the mudstone.

Although it is not possible to provide a definitive statement concerning uranium concentrating mechanisms within the Catskill Formation, Figure 11 presents a possible scheme by which all the known uranium occurrences may be explained. Uranium may have entered the rocks contemporaneously with deposition, being adsorbed onto iron-titanium hydroxides (or possibly onto clay minerals). These hydroxides would have been deposited largely in mudstone horizons, and to a lesser extent in the matrix of the coarser sandstones. A change in ground-water chemistry could cause the uranium to be desorbed, at which time it would enter the ground-water regime, probably as a uranyl carbonate complex. Uranium enriched ground water could enter the system either from an outside source or by compaction of mudstone horizons. There are several mechanisms by which this uranium could be precipitated. If none of these mechanisms were operative at any particular time, uranium would be removed from the system still dissolved in the ground water.

The Subclass 243 occurrences of alluvial-fan association appear to show a strong correlation of uranium and visible organic accumulations, which indicates that organic complexing may be the most important precipitating mechanism at these locations. Precipitation by mobile reductants (generated by decay of organics) or precipitation as compounds with other elements (silicon, vanadium, arsenic) may also have occurred. It is probable that uranium-enriched ground water flowed through the more permeable horizons and that this flow was confined by mudstone layers.

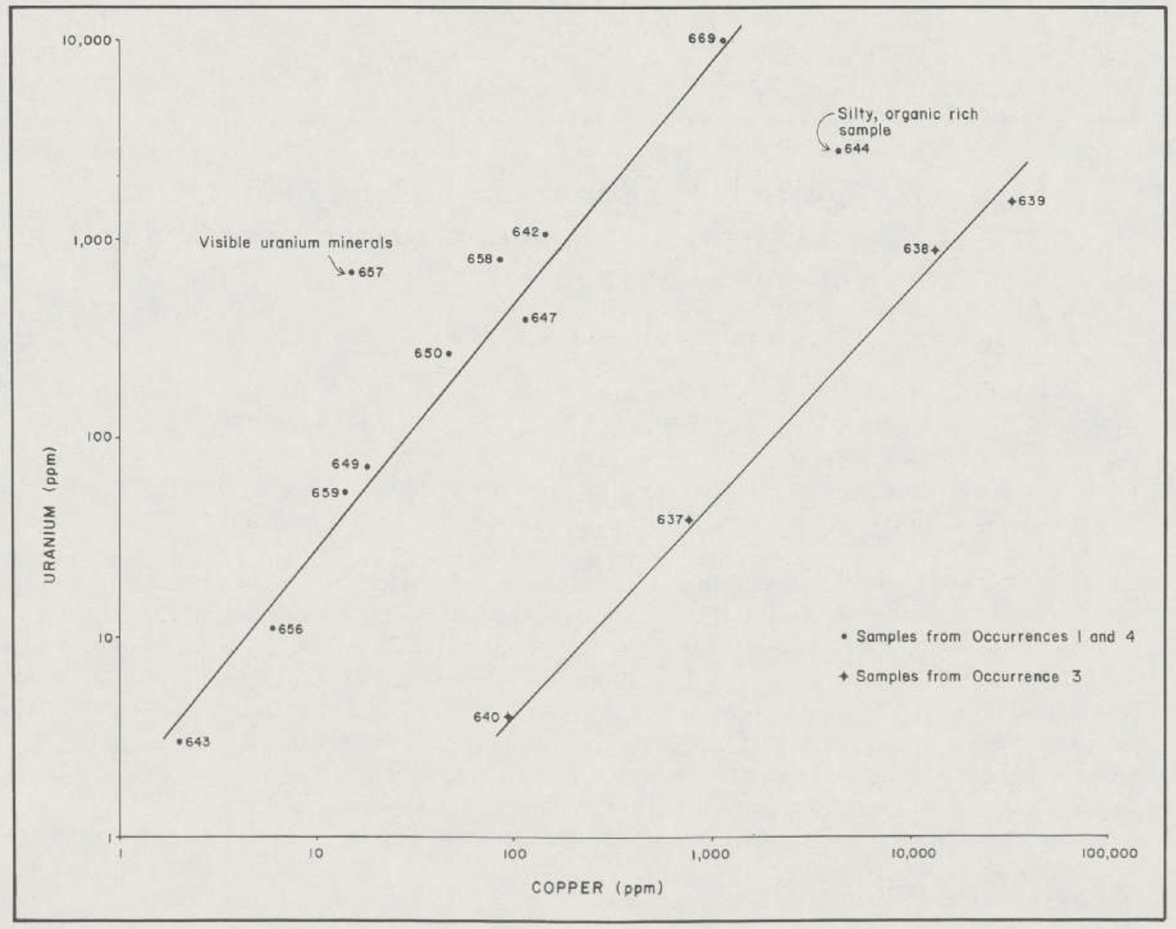


Figure 10. Plot of uranium and copper for channeled sandstones in the Glen Wild area.

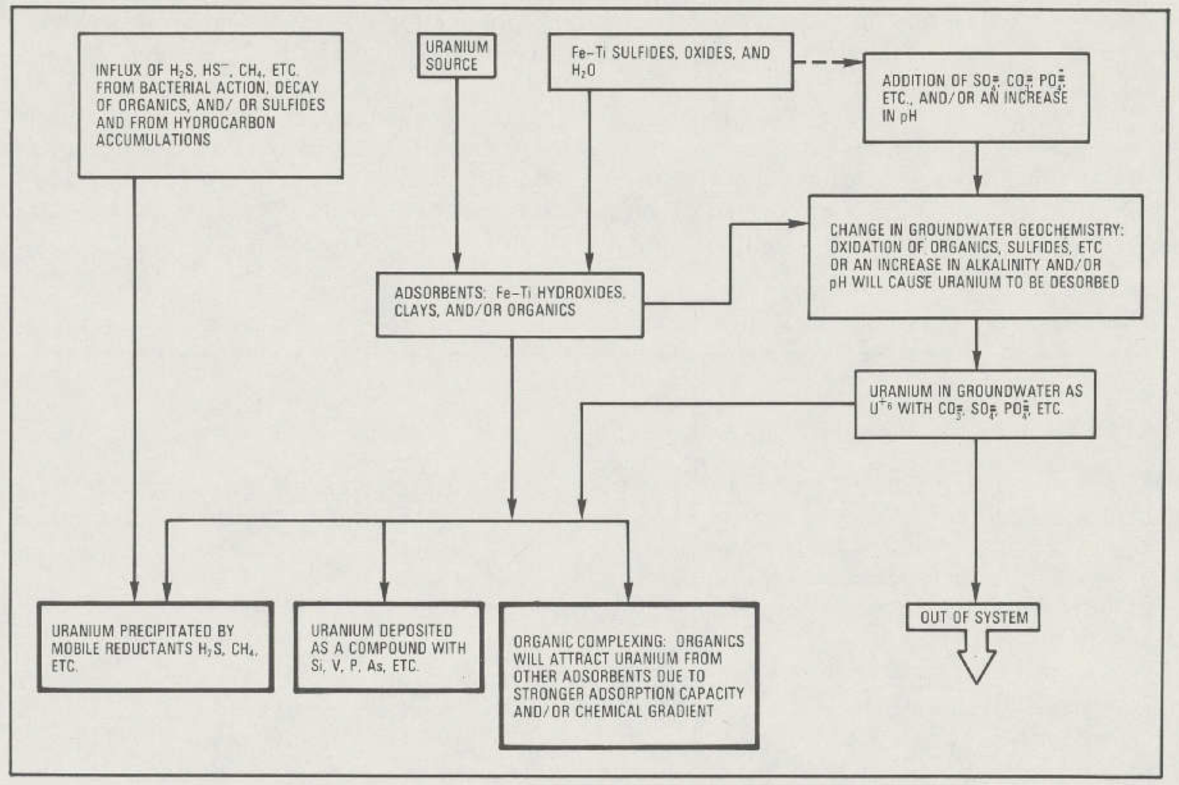


Figure 11. Flow chart of possible concentration mechanisms for uranium in the Catskill Formation.

Volume estimates for units within the Catskill Formation are difficult to derive because of the complex facies interrelations and the rapid changes in thickness of the different horizons. Subsurface information is lacking; only 28 deep wells are known to penetrate the Catskill Formation in the Scranton Quadrangle (Pl. 8), and they are widely separated. Glaeser (1974) compiled a subsurface analysis of the Catskill Formation in northeastern Pennsylvania; however, his study did not include the alluvial-fan environment. Plate 9, taken from Glaeser's report, supports the overall view of the Catskill as a clastic wedge, thinning toward the west. A maximum thickness of 4250 m is noted for terrestrial deposits in the eastern part of the region, decreasing to 600 m in the west.

The alluvial-fan environment (Pl. 1a, Area C) covers an area of 1620 km^2. The area shown is somewhat arbitrary and is based on available mapping and evidence from field reconnaissance. Additional favorable rocks may be found beyond the mapped boundaries. The thickness of the alluvial-fan succession is not known but may exceed 300 m. Mineralized horizons within the section are probably only 10 to 20 m wide. All nine of the Glen Wild occurrences are found within a 43-km^2 area.

ENVIRONMENTS UNFAVORABLE FOR URANIUM DEPOSITS

Seven geologic environments in the Scranton Quadrangle are deemed to be unfavorable for deposits of at least 100 tons of U_3O_8 in rocks having an average grade not less than 100 ppm. These unfavorable environments are:

- the southeastern massif of the Reading Prong, exclusive of that part denoted as favorable Area B (Pl. 1a);
- the lower Paleozoic sedimentary units;
- the Beemerville nepheline syenite complex;
- the Upper Devonian Catskill Formation, exclusive of the favorable basal alluvial-fan facies (Area C, Pl. 1a);
- Mississippian units;
- Pennsylvanian units; and
- peat bogs

SOUTHEASTERN MASSIF OF THE READING PRONG

As previously discussed, the only type of uranium occurrences expected in the southeastern massif of the Reading Prong are small metasomatic concentrations at the contact between leucocratic igneous rocks and metasediments. Such contact-metasomatic occurrences do exist, but field investigation has shown that, with the exception of the area around Monroe, New York (favorable Area B, discussed in the preceding section), uranium deposits of the minimum size and grade specified for this study are unlikely.

During the period of partial melting, the lithostatic pressure in the southeastern massif never eased to the same extent as in the northwest tectonic block. A less pervasive fluid phase developed in this higher pressure environment. Uranium could migrate short distances by metasomatic processes, but the removal of uranium from large volumes of rock apparently did not occur. Thus, the concentrations observed tend to be very small.

LOWER PALEOZOIC SEDIMENTARY UNITS

The lower Paleozoic (Cambrian through Middle Devonian) sedimentary units of the quadrangle are considered unfavorable for hosting significant uranium occurrences. As stated in the "Geologic Setting" section, these rocks are primarily of marine origin with only limited terrestrial deposits.

The Lower Cambrian Hardyston Formation displays both fluvial and marine characteristics (Aaron, 1969). The arkosic lower part of the unit has been reported to contain placerlike concentrations of resistate thorium minerals in outcrops south of the Scranton Quadrangle (Smith, 1974). Negligible uranium is associated with these placers. Similar heavy-mineral concentrations have not been found in the Hardyston rocks of the Scranton Quadrangle. Moreover, no other favorable environments are expected in the Hardyston Formation. The entire unit is only some 30 m (100 ft) in thickness and discontinuous in exposure. The sandstone part of the section is reduced (greenish gray in color) and has no shaly confining layers or organics.

Ordovician rocks in the quadrangle are exclusively marine, forming a thick succession of gray shale, limestone, and limited graywacke. These rocks display no characteristics that indicate favorability for uranium occurrences.

The Lower and Middle Silurian terrestrial deposits (Shawangunk Conglomerate and Bloomsburg sandstone) on the whole appear unfavorable for uranium occurrences, even though they exhibit some favorable characteristics. These rocks were deposited under fluvial conditions and show well developed and preserved channel features. Sources for these units were most likely granitic and metamorphic rocks and some reworked quartz arenite. Red beds are common; however, there are only poorly defined shale horizons to act as confining layers to ground-water flow. Fossil-plant material is notably absent. At one location, the Pahaquarry Copper Mine on the Delaware River, a color boundary between red and green fine sandstone cuts across bedding. These rocks display bleached horizons and are known to contain disseminated copper sulfides (up to several percent copper). However, in this relatively favorable situation, no indication of uranium mineralization was found.

Elsewhere in the Silurian Shawangunk Formation are numerous lead-zinc deposits in fracture zones. These deposits may be of either hydrothermal (Sims and Hotz, 1951) or biogenetic (Heyl, 1979) origin. Four such deposits were visited during our field investigations, but no indication of uranium above background levels was found.

The Lower and Middle Devonian rocks in the Scranton Quadrangle are dominated by marine limestones and fine-grained clastics. The fine-grained nature of the rocks, the lack of organics and of suitable structural traps, and the dominant marine association make these units unfavorable for hosting uranium deposits.

BEEMERVILLE NEPHELINE SYENITE COMPLEX

The Upper Ordovician (or Lower Silurian?) Beemerville complex in northwestern New Jersey consists of two stocklike bodies of nepheline syenite and associated lamprophyre, phonolite, tinguaite, bostonite, and carbonatite dikes. There is no indication that the complex contains concentrations of uranium large enough to be considered favorable, although a few anomalous samples have been found.

Smith and others (1955) report an enrichment of 13 to 46 ppm U_3O_8 for granular nepheline syenite from Beemerville. Samples collected for the present study (Occurrence 15, Pl. 2) show only 3 to 4 ppm U_3O_8, indicating that the syenite bodies are not uniformly mineralized. Minor amounts of sphene and zircon in the rock may account for some of the uranium present.

Uranium enrichment was also observed in the lamprophyre diatreme known locally as Rutan Hill (Occurrence 16, Pl. 2). One sample, identified as phonolite, showed 26 ppm U_3O_8. Bostonite dikes in the vicinity of Beemerville were found to contain a maximum of 19 ppm U_3O_8 (Smith and others, 1955). However, no uranium enrichment in amounts considered significant within the guidelines of the present study has been determined.

UPPER CATSKILL FORMATION

The Upper Devonian Catskill Formation is primarily terrestrial, having been deposited in upland alluvial-fan, lowland flood-plain, and coastal delta-plain environments. However, the Catskill in the Scranton Quadrangle, exclusive of the basal alluvial-fan facies, is considered unfavorable for the development of uranium deposits despite having some characteristics favorable for occasional uranium concentrations, as well as having several known, small occurrences. Those portions of the upper Catskill that contain known uranium concentrations are extensive, but the characteristics favorable for such concentrations are very poorly developed.

Sporadic minor concentrations of uranium are found in Pennsylvania along the basal contact of the Duncannon Member, as defined by the Pennsylvania Geological Survey. Both the Duncannon and the underlying Poplar Gap Member are higher in the Catskill section than the strata at Glen Wild (favorable Area C), and although the Duncannon displays features characteristic of meandering- and braided-river deposits, the rocks have an overall finer grain size than those near Glen Wild. Also, channels are less distinct and tend to be shallower, and the presence of organics is less pronounced.

South of the Scranton Quadrangle, the lower Duncannon rocks at the Penn Haven Junction uranium deposit near Jim Thorpe, Pennsylvania, are thought to lie closer to the sediment source area than the Duncannon within the quadrangle. Braided-stream features are better developed there, the rocks have a coarser grain size, and larger organic accumulations are present in and around the channels.

Near Waymart, Pennsylvania, at the Millen Farm (Occurrence 11, Pl. 2), uranium has been found in association with copper at the base of the Duncannon. The rock at this locality is a fine-grained, red, cross-bedded sandstone containing thin gray shale laminae; petrographic analysis shows it to be a micaceous litharenite (MHI 653, App. E). Field investigations indicated that anomalous radioactivity is linked to fossil-plant accumulations in the sandstone. No uranium minerals were found, suggesting that all the uranium is contained in organic complexes. The highest radioactivity occurs in bleached zones that show traces of malachite, azurite, and organic material. These bleached zones roughly parallel the bedding.

McCauley (1961) reported another copper-uranium concentration in two abandoned copper prospects at the base of Moosic Mountain near Mt. Cobb, Pennsylvania, at the same stratigraphic level as the Millen Farm. However, the authors could find no trace of the prospect pits, and a radiometric traverse across the lower slopes of the mountain showed no anomalous readings.

West of Carbondale, Pennsylvania, the Lally No. 1 deep well (Pl. 8) intersects a radioactive zone which may be the basal Duncannon contact. The gamma-ray log of the hole shows a definite change in lithology at the same level as the maximum radioactive response. As there are no other deep wells within 15 km of this hole, the lateral extent of any mineralized area cannot be determined.

During field reconnaissance in the Scranton Quadrangle, only one actual occurrence of uranium was identified in the undifferentiated portion of the Catskill Formation. In a road cut near Bethel, New York, some uranium enrichment occurs in association with organic material and copper (Occurrence 10, Pl. 2). The rocks at this site display the typical Catskill pattern of upward-fining sequences of gray sandstone into red mudstone. However, the overall nature of the rocks is finer grained than in the alluvial-fan succession. The strongest radioactivity is associated with a single organic-rich horizon within a fine-grained gray sandstone unit at the base of a depositional cycle. The anomalous zone is less than 3 m long and about 1 m wide. The only uranium mineral identified from this site is a secondary barium uranyl phosphate, probably meta-uranocircite. Most of the uranium may be structurally bound with the organics. Secondary copper minerals identified in thin section are bornite, chalcopyrite, chalcocite, chalcanthite, and malachite. The mudstones in the area are slightly anomalous (twice regional background) and may be the cause of the airborne radiometric anomaly (LKB Resources, Inc., 1978).

Near Avery, Pennsylvania, in the western part of the quadrangle, another reported copper-uranium occurrence in the Catskill Formation (Rose, 1970) was investigated, but no evidence of anomalous radioactivity was found.

MISSISSIPPIAN UNITS

No uranium minerals have been found in the Mississippian units within the Scranton Quadrangle. The Mississippian Pocono and Mauch Chunk Formations were deposited in a near-marine environment following a period of marine transgression at the end of Catskill time. The rocks exposed represent deposition on broad, heavily vegetated delta plains and swamps, with occasional periods of higher energy deposition. This environment is not favorable for uranium concentration. The depositional environments in the Scranton Quadrangle are considerably different from those at the Mt. Pisgah uranium deposit near Jim Thorpe, Pennsylvania. The rocks at Jim Thorpe were deposited in a fluvial environment, probably an alluvial fan.

The Pocono Sandstone in the Scranton Quadrangle is assumed to be fluvial in origin (Sevon, 1975a), but has obscure or poorly developed bedding features with very thin, poorly exposed shale layers and no known fossils. Near Laurel School, Pennsylvania, is a small mineralized zone in the upper Pocono Formation near the contact with the overlying Mauch Chunk (Occurrence 13, Pl. 2). Average scintillometer readings around the site are 150 cps (15 ur), with thin mudstone layers consistently reading 250 to 300 cps (25 to 30 ur). A localized high of 1,400 cps (290 ur) was found in a 4-m^2 area of gray pyritic sandstone and mudstone. An assay of a sample from this spot showed 600 ppm U_3O_8 and slight enrichment of manganese and lead. There are no visible organics or uranium minerals in any of the rocks exposed.

The Mauch Chunk Formation consists of over 50% fine- to medium-grained, planar and cross-bedded, red to purple sandstone. The remainder of the formation contains grayish-red siltstones and discontinuous limestone beds. Fossil-plant accumulations are common, sometimes forming thin coal seams that are indicative of a paludal depositional environment. This depositional environment does not appear to have been conducive to the development of characteristics favorable for the concentration of uranium. Well-defined channels are lacking in the sandstones, and the overall grain size is too fine. The shale-to-sandstone ratio is greater than 1.0. Fossil-plant debris accumulated in broad swamps rather than in channels. There are no reported uranium occurrences in the Mauch Chunk within the Scranton Quadrangle, nor were any discovered during the course of field investigations.

PENNSYLVANIAN UNITS

Pennsylvanian coal-bearing rocks of the Northern and Middle Anthracite Basins (Fig. 2) also are considered unfavorable for hosting uranium deposits. The Pottsville and Llewellyn Formations consist of gray to white, interbedded shale, siltstone, sandstone, and conglomerate. Both formations have highly fossiliferous horizons, and the Llewellyn Formation contains economic anthracite coal beds. Deposition of these rocks was in a fluvial and paludal environment. The sandstones are cross-bedded and display marked channel development.

Field examinations show that, although distinct fluvial sedimentation systems containing abundant organic material are displayed in these rocks, there are no known uranium concentrations. Vine (1962) has shown that the anthracite measures are barren of uranium. The present study also shows that the sedimentary layers on either side of a coal seam have minimal levels of uranium. The lack of significant red (oxidized) horizons indicates that any postdepositional ground water must have been uniformly reduced, and thus would have kept uranium immobile and disseminated. Also, in a coal-forming environment, water would have been largely stagnant; therefore, no great volumes of uranium could be accumulated.

PEAT BOGS

Peat bogs are found throughout the Scranton Quadrangle, their location controlled by postglacial topography rather than by bedrock type. Nearly all of the peat sampled has uranium concentrations above those found in surrounding rocks. The abundance of uranium in the peat samples appears to be a direct reflection of the uranium abundance in underlying or nearby rocks. Peat materials overlying Cambro-Ordovician, Devonian, and Mississippian sedimentary units have insignificant levels of uranium. (None of these rocks have elevated uranium contents.) The highest uranium values in peat came from the Reading Prong region in association with more highly enriched granitic and pegmatitic rocks.

Laboratory experiments have shown that peat material has the potential for fixing uranium to concentrations 10,000 times those found in ground water (Szalay, 1964). Theoretically, peat could contain up to 10% uranium by dry weight. Natural peats tend to be considerably less enriched than this theoretical limit. In a natural environment peat bogs will probably never reach the minimum size and grade to be called a uranium deposit. However, because of their uranium-concentrating ability, peat bogs might be used to locate bedrock uranium occurrences in areas of little exposure.

UNEVALUATED ENVIRONMENTS

In the Scranton Quadrangle two environments remain unevaluated for uranium potential: the Spechty Kopf Formation, because of paucity of exposure and lack of sufficient data; and the Newark Basin, because of cultural density and inadequate subsurface information.

SPECHTY KOPF FORMATION

The Spechty Kopf Formation, which has been defined in the area of the Northern and Middle Anthracite Basins, is considered transitional between the Upper Devonian Catskill and Lower Mississippian Pocono Formations. Rocks exposed represent a period of marine transgression at the end of Catskill time. The Spechty Kopf consists of alternating fine sandstone layers, commonly olive gray to gray. At the base of the formation is a sporadic occurrence of diamictite, an unsorted mixture of clay, silt, sand, and pebbles, which may have been deposited as a submarine debris flow (Sevon, 1975a).

A uranium occurrence in the Spechty Kopf was found in a road cut along the Northeast Extension of the Pennsylvania Turnpike (Occurrence 14, Pl. 2). The rocks there are a sequence of red sandstone and rusty-weathered, gray, fine sandstone and shaly siltstone. Some cross-bedding is visible in the sandstones. The color change from red to gray cuts across bedding and is apparently a postdepositional feature. The beds occupy the northern limb of a small northeast-trending anticline and dip approximately 15° NW (mapping by Sevon, 1975a).

Scintillometer readings 2.5 to 5 times local background (250 to 500 cps; 25 to 74 ur) were obtained from a 1- by 15-m section of red sandstone along the outcrop face. An additional 15-m section within the gray sandstone produced isolated radiometric highs (1,600 cps or 350 ur, maximum). A sample of anomalous red sandstone assayed 110 ppm U_3O_8, and one from the gray zone showed 410 ppm U_3O_8. Yellow secondary uranium minerals and roll structures in the gray sandstone that had been previously reported (U.S. Atomic Energy Commission and U.S. Geological Survey, 1968) could not be confirmed during the present investigation. A second reported uranium occurrence in the Spechty Kopf, 1.9 km farther south along the turnpike, was examined but showed insignificant radioactivity. Away from the turnpike road cuts, radiometric traverses showed only background radiation levels.

The Spechty Kopf Formation is easily weathered, and good exposures are rare or nearly inaccessible. Also, very little can be determined about the uranium concentrating mechanism involved at Occurrence 14. For these reasons it is felt that this formation should be considered unevaluated.

NEWARK BASIN

The Triassic Newark Basin occupies about 310 km^2 in the southeast corner of the Scranton Quadrangle (Fig. 2). The high degree of cultural development, coupled with a paucity of rock exposure and of well information, did not permit detailed evaluation of uranium potential.

Rifting during the Triassic-Jurassic Period initiated extensive basin sedimentation which was periodically interrupted by basalt flows. Fanglomerates that developed along the northwestern boundary of the basin are preserved as the Brunswick Formation. Rapid fining of grain size is seen in this formation away from the sediment source. In the center of the basin fine sandstones are interlayered with the dark mudstones and carbonates of the Lockatong Formation that represent deposits in swamps and ephemeral lakes.

South of the quadrangle, the Lockatong Formation is known to contain widespread intermediate-grade deposits with 100 to 200 ppm U_3O_8 (Turner-Peterson, 1977). At present, however, the extent of the Lockatong Formation in the Scranton Quadrangle, or the degree of mineralization, cannot be estimated.

INTERPRETATION OF AERIAL RADIOMETRIC DATA

An aerial radiometric survey of the Scranton Quadrangle was flown in 1976–1977 by LKB Resources, Inc., as part of the NURE program. Its purpose was to map the regional near surface distribution of natural radioelements and to delineate areas enriched in uranium relative to the measured regional background. Twenty-three east-west flight lines were flown at a spacing of approximately 5 km (3.13 mi); ground clearance was nominally 122 m (400 ft).

Gamma-ray spectrometric data, corrected for cosmic and atmospheric background, were tabulated for each mapped unit in the quadrangle (LKB Resources, Inc., 1978). A mean response for each formation was derived, and standard deviation levels were calculated. Averaged data were plotted on a map, and anomalies were selected by degree of deviation from the established mean. Single points with a value of three standard deviations or more above the mean were said to be significant. Those points with values only one to two standard deviations above the mean were also considered significant if they occurred in groups (Saunders and Potts, 1978). The significance of an anomaly was also related to associated thorium-to-uranium and potassium-to-uranium values, as well as to gross-count values. Information on surface water, soil cover, and degree of human habitation and activity was used to establish priorities for the chosen anomalies.

Field checking of the aerial radiometric survey results showed little coincidence between LKB Resources–selected anomalies and uranium concentrations. In many cases an anomaly was related to agricultural or industrial activity. Anomalies clustering around Honesdale, Pennsylvania, are due to the differential response of low hills of sandstone and adjacent swamps. The only LKB Resources–selected anomaly that is coincident with the occurrence of uranium is found near Bethel, New York (anomalies 32, 33, 34; LKB Resources, Inc., 1978). It is felt that the aerial anomalies at this locality were caused by broad areas of slightly anomalous mudstone (2 to 4 times background) exposed at, or very near, the surface.

An alternative to the statistical evaluation of the raw count data is to compute equivalent potassium, uranium, and thorium concentration for each datum point. These values are then plotted on maps to provide a picture of the actual surface abundance of the radioelements (M. Critchley, BFEC, written comm., 1979).

Seven relative highs have been defined for the Scranton Quadrangle on the basis of examination of the entire data set. Plate 3 shows these seven areas, as well as areas of anomalous equivalent uranium abundance.

Area 1 encompasses rocks of both marine and terrestrial origin and coincides with a portion of favorable Area C. (Compare with Pl. 1a.) This area was selected because of high equivalent uranium values relative to data for the entire quadrangle.

Area 2 corresponds with the lower half of the Northern Anthracite Basin and the incised drainage of the Susquehanna River. Anomalous radiometric values may be caused by large exposures of rock in numerous strip mines and along the river, as well as by cultural features.

Area 3 covers a broad area of the Catskill Formation west of the Anthracite Basins. It is characterized by high equivalent uranium values relative to the rest of the quadrangle. This area includes a reported copper-uranium occurrence.

Area 4 is an extensive area of moderately high equivalent uranium corresponding with favorable Area A (Pl. 1a).

Area 5 covers a large portion of undifferentiated Catskill Formation. The equivalent uranium values that define this anomalous area are only slightly higher than the quadrangle average.

Area 6 is underlain by early Paleozoic marine strata in southeastern New York. The equivalent uranium values that define this anomalous area are only slightly higher than the quadrangle average.

Area 7 is a small, circular anomaly in the Catskill Formation east of Wilkes-Barre, Pennsylvania. It is defined by high equivalent uranium values relative to the entire quadrangle.

These seven anomalies represent an interpretation of data from the entire quadrangle. On such an interpretation, favorable Area C does not stand out as significant. However, if one examines only the data from that part of the quadrangle underlain by Area C, delineation of formational relative highs is possible (Pl. 3). The Glen Wild area and the Lackawaxen Conglomerate become anomalous when only the data from the upper and lower Walton formations (and equivalents) are examined. Other smaller anomalies can be seen throughout Area C, possibly indicating more extensive mineralized areas.

INTERPRETATION OF HYDROGEOCHEMICAL AND STREAM-SEDIMENT RECONNAISSANCE DATA

Results of the Hydrogeochemical and Stream-Sediment Reconnaissance (HSSR) survey of the Scranton Quadrangle have been reported by Ferguson and Jones (1979). A BFEC interpretation of these data is presented in Plate 4. Five significant anomalies have been identified.

Anomaly A, in the Monroe, New York, area is associated with three sample points in the vicinity of uranium Occurrences 17 and 18 (Pl. 2). In this area uranium analyses were high for both ground and stream water. Regression analysis also showed high uranium residuals in ground water and stream sediments. The persistence of this anomalous area on several different plots makes it desirable for more detailed field examination.

Two stream-sediment samples from the Miles Standish Mine area south of Warwick, New York, are related to Anomaly B. One sample was collected 400 m downslope from uranium Occurrence 22 (Pl. 2 and 12) at the Raynor Mine. The second sample was taken within 100 m of the abandoned Green Mine in Wawayanda State Park, New Jersey. Magnetite orebodies at the latter locality are associated with amphibole gneiss and interlayered alaskite. A radiometric survey over the site showed the alaskite to have 2 to 5 times the local background response. Uranium in the stream sediments is high (10 ppm), and the thorium-to-uranium ratio is very low (less than 0.5). There is also a high uranium residual from regression analysis.

Anomaly C, west of Warwick, New York, appears to be associated with a block of biotite-hornblende granite and interlayered gneisses (known locally as Mt. Adam and Mt. Eve) rising above the Precambrian Franklin Marble and Cambrian marine strata. About 2 km southwest of the granite outcrop, a ground-water sample from the Franklin Marble showed greater than 20 ppb uranium. A moderate stream-water uranium anomaly (2 ppb) also exists less than 1 km southwest of the granite. The stream sampled flows across a peat-rich soil horizon that may serve to concentrate uranium. Field examination found the granite to contain abundant magnetite and fluorite in its coarser portions. Historical records report arsenopyrite and large tourmaline crystals in the immediate vicinity; such crystals are indicative of hydrothermal and pegmatitic activity.

Anomaly D is based on one sample collected 2.2 km east of Bethel, New York. The anomaly is evident only on plots of uranium in stream sediments (10 ppm) and stream sediment residuals. Uranium Occurrence 10 (Pl. 2) is several kilometers west of this anomaly, and the whole region appears to be underlain by slightly anomalous red mudstones (greater than twice background).

Anomaly E covers a broad area of the Catskill Formation north of Honesdale, Pennsylvania. A factor analysis of the multielement data shows uranium to be correlated with lanthanum, aluminum, thorium, and samarium, indicating that the elevated uranium values in ground water in the area are due to resistate minerals (primarily monazite and zircon).

There were no significant anomalies found in ground water, stream water, or stream sediments from the Glen Wild area. This may be due to the nature of the stream drainage in the region or to the fact that most of the uranium appears to be structurally bound with organics and thus is not readily leached. Results of a detailed sampling survey in the Glen Wild area, undertaken by the Savannah River Laboratory for the NURE program, were not available for incorporation in this report.

Hydrogeochemical and stream-sediment surveys appear to be applicable only in certain areas of the Scranton Quadrangle. In the metamorphic terrain of the Reading Prong, uranium is readily leached and easily enters the hydrologic system. Here, exploration by hydrogeochemical techniques shows the greatest promise. In the Catskill area, however, uranium is associated with fossil-plant debris and appears to be less readily leached. Most anomalies seen in the Catskill Formation are caused by uranium from resistate minerals and do not reflect truly anomalous concentrations.

RECOMMENDATIONS FOR FURTHER STUDY

Because of the reconnaissance nature of this study, much work can still be done to appraise the economic potential of various uranium occurrences and favorable areas. Some suggestions for further work include the following:

- In the area of Warwick, New York, detailed investigations are desirable to establish the economic potential of the Warwick Mountain and Taylor Mountain trend. Ground-radiometric surveys on a closely spaced grid can indicate the extent of surface anomalies. Radioactivity from subsurface uranium deposits can be detected by a radon gas survey. Various geophysical techniques (resistivity, S.P., I.P., AFMAG) can be used to distinguish areas of sulfide and magnetite occurrence. (The more sulfide-rich zones seem to host greater concentrations of uranium.) Detailed mapping can provide clues to the geologic history of the area and delineate potential structural traps for uranium. Once this background information is collected, drilling can be undertaken to establish grade and abundance of ore. Finally a study should be undertaken to determine the feasibility of producing magnetite and rare earths as coproducts of uranium.
- In the area of Glen Wild, New York, studies should be initiated to establish the position of the uranium-bearing horizons within the framework of Catskill sedimentation. Also, test drilling should be carried out to determine the grade and lateral extent of the uranium deposits.
- Water and oil wells that penetrate the basal Duncannon contact should be logged, and water samples taken, to determine the extent of mineralized area along this stratigraphic horizon.
- Raw data from the airborne radiometric survey can be used to generate plots of equivalent uranium and thorium that may prove more useful than plots of statistical variation. Plate 3 details several of these equivalent uranium anomalies that should be field checked. Also, profiles of the single-record data can be examined for coincident peaks in the uranium and gross-count channels that may indicate mineralized areas.
- Five HSSR anomalies have been identified, three of which (Anomalies A, B, and C, Pl. 4) are considered highly significant. Anomalies A and C are of undetermined origin and should be field checked. The HSSR has been shown to be an effective tool for delineating uranium anomalies in the Reading Prong, possibly because of uranium leaching in this type of terrain. More study is needed to determine why similar-scale anomalies are not found around known mineralized areas in the Catskill region.
- The possibility of radioactive peat bogs as indicators of buried uranium deposits should be investigated. It is known that a peat deposit in the vicinity of a highly anomalous uranium occurrence will show very high uranium values. Sampling of bogs in areas of little rock exposure may provide a new prospecting tool. Field tests in areas of known bedrock uranium concentration should demonstrate the minimum distance between bog and bed rock for a significant uranium level in the peat.

SELECTED BIBLIOGRAPHY

Aaron, J. M., 1969, Petrology and origin of the Hardyston Quartzite (Lower Cambrian) in eastern Pennsylvania and western New Jersey, *in* Subitzky, Seymour, ed., Geology of selected areas in New Jersey and eastern Pennsylvania (and guidebook of excursions): Geological Society of America Annual Meeting, Atlantic City, New Jersey: New Brunswick, New Jersey, Rutgers University Press, p. 21–34.

Allen, J. R. L., and Friend, P. F., 1968, Deposition of the Catskill facies, Appalachian region: With notes on some other Old Red Sandstone basins, *in* Klein, G. deVries, ed., Late Paleozoic and Mesozoic continental sedimentation, northeastern North America: Geological Society of America Special Paper 106, p. 21–74.

Alvord, D. C., and Drake, A. A., Jr., 1971, Geologic map of the Bushkill Quadrangle, Pennsylvania–New Jersey: U.S. Geological Survey Geologic Quadrangle Map GQ–908, scale 1:24,000.

Andreasen, G. E., Smith, F. C., and others, 1962a, Aeromagnetic map of the Popolopen Lake Quadrangle, Orange and Rockland Counties, New York: U.S. Geological Survey Geophysical Investigations Map GP–340, scale 1:31,680.

Andreasen, G. E., Vargo, J. L., and others, 1962b, Aeromagnetic map of the Thiells Quadrangle, Rockland and Orange Counties, New York: U.S. Geological Survey Geophysical Investigations Map GP–342, scale 1:31,680.

Ash, S. H., Dierks, H. A., Kynor, H. D., Lesser, W. H., Miller, P. S., and Romischer, W. M., 1954, Flood prevention in anthracite mines, northern field, Project 1 (Lackawana): U.S. Bureau of Mines Bulletin 545, scale 1:200,000.

Austin, S. R., and D'Andrea, R. F., Jr., 1978, Sandstone-type uranium deposits, *in* Mickle, D. G., and Mathews, G. W., eds., Geologic characteristics of environments favorable for uranium deposits: U.S. Department of Energy Open-File Report GJBX–67(78), p. 87–119.

Baillieul, T. A., and Indelicato, G. J., 1978, Uranium in the Glen Wild area, Woodridge, New York, 7.5-minute Quadrangle: U.S. Department of Energy Open-File Report GJBX–46(78), 15 p.

Bayley, W. S., 1910, Iron mines and mining in New Jersey: New Jersey State Geologist's Final Report, v. 7, 512 p.

Berg, T. M., and Sevon, W. D., 1977, Pocono Pines and Mount Pocono Quadrangles, Monroe County: Pennsylvania Geological Survey Atlas A 204cd, scale 1:24,000.

Bucek, M. F., 1971, Surficial geology of the East Stroudsburg 7½ minute Quadrangle, Monroe County, Pennsylvania: Pennsylvania Geological Survey Atlas 214C, 40 p., scale 1:24,000.

Buddington, A. F., and Baker, D. R., 1961, Geology of the Franklin and part of the Hamburg Quadrangles, New Jersey: U.S. Geological Survey Miscellaneous Investigations Map I–346, scale 1:24,000.

Bull, W. B., 1972, Recognition of alluvial-fan deposits in the stratigraphic record, *in* Rigby, J. K., and Hamblin, W. K., eds., Recognition of ancient sedimentary environments: Society of Economic Paleontologists and Mineralogists Special Publication 16, p. 63–83.

Cameron, C. C., 1970, Peat deposits of northeastern Pennsylvania: U.S. Geological Survey Bulletin 1317–A, 87 p.

Chute, N. E., 1954–60, Limestone areas of Ulster County: New York State Museum and Science Service unpublished maps, scales 1:24,000 and 1:31,680.

Colony, R. J., 1921, The magnetite iron deposits of southeastern New York: New York State Museum and Science Service Bulletin 249–250, 161 p.

Crowl, G. H., 1971, Pleistocene geology and unconsolidated deposits of the Delaware Valley, Matamoras to Shawnee on Delaware, Pennsylvania: Pennsylvania Geological Survey General Geologic Report 60, 40 p., scale 1:24,000.

Dallmeyer, R. D., 1974a, Metamorphic history of the northeastern Reading Prong, New York and northern New Jersey: Journal of Petrology, v. 15, no. 2, p. 325–359.

----1974b, Tectonic setting of the northeastern Reading Prong: Geological Society of America Bulletin, v. 85, p. 131–134.

Dodd, R. T., Jr., 1965, Precambrian geology of the Popolopen Lake Quadrangle, southeastern New York: New York State Museum and Science Service Map and Chart Series 6, 39 p., scale 1:24,000.

Drake, A. A., Jr., 1969, Precambrian and lower Paleozoic geology of the Delaware Valley, New Jersey–Pennsylvania, *in* Subitzky, Seymour, ed., Geology of selected areas in New Jersey and eastern Pennsylvania (and guidebook of excursions): Geological Society of America Annual Meeting, Atlantic City, New Jersey: New Brunswick, New Jersey, Rutgers University Press, p. 51–131.

Engineering and Mining Journal, 1957, Eastern uranium mine prepares to ship product: v. 158, no. 6, p. 81.

Ferguson, R. B., and Jones, P. L., 1979, Scranton 1° x 2° NTMS area, New Jersey, New York, and Pennsylvania, preliminary basic data report, NURE hydrogeochemical and stream sediment reconnaissance: U.S. Department of Energy Open-File Report GJBX–2(79), 226 p.

Fisher, D. W., 1955–60, 1967–69, Portions of the Rosendale, Rhinebeck, Millbrook, Ellenville, Newburg, Poughkeepsie, Clove, Schunnemunk, Port Jervis, Coxsackie, Catskill, Kinderhook, Copake, and Pittsfield Quadrangles: New York State Museum and Science Service unpublished maps, scale 1:24,000.

Fisher, D. W., and others, 1970, Geologic map of New York State, Lower Hudson sheet: New York Museum and Science Service Map and Chart Series, scale 1:250,000.

Fletcher, F. W., and Woodrow, D. L., 1970, Geology and mineral resources of the Pennsylvania portion of the Milford and Port Jervis 15-minute Quadrangles: Pennsylvania Geological Survey Atlas 223, scale 1:62,500.

Folk, R. L., 1968, Petrology of sedimentary rocks: Austin, University of Texas, Hemphills, p. 120–126.

Frimpter, M. H., 1967, Geology of the Thiells Quadrangle, New York: Boston University, Ph.D. dissertation, 145 p., scale 1:24,000.

Glaeser, J. D., 1974, Upper Devonian stratigraphy and sedimentary environments in northeastern Pennsylvania: Pennsylvania Geological Survey General Geologic Report G 63, 89 p.

Grauch, R. I., 1977, Precambrian uranium associated with a metamorphosed massive sulfide body—Camp Smith area, New York, *in* Campbell, J. A., ed., Short papers of the U.S. Geological Survey Uranium-Thorium Symposium, 1977: U.S. Geological Survey Circular 753, p. 41–43.

Gray, Carlyle, and Shepps, V. C., 1960, Geologic map of Pennsylvania: Pennsylvania Department of Environmental Resources, Topographic and Geologic Survey Map 1, scale 1:250,000 [reprinted 1975].

Hagner, A. F., Collins, L. G., and Clemency, C. V., 1963, Host rock as a source of magnetite ore, Scott Mine, Sterling Lake, New York: Economic Geology, v. 58, p. 730–768.

Hague, J. M., Baum, J. L., Herrmann, L. A., and Pickering, R. J., 1956, Geology and structure of the Franklin-Sterling area, New Jersey: Geological Society of America Bulletin, v. 67, p. 435–473.

Hall, L. M., Helenek, H. L., Jackson, R., Caldwell, C., Mose, D. G., and Murray, D. P., 1975, Some basement rocks from Bear Mountain to the Housatonic Highlands, Trip A–1: New York, New England Intercollegiate Geological Conference Guidebook, p. 1–29.

Helenek, H. L., 1971, An investigation of the origin, structures and metamorphic evolution of major rock units in the Hudson Highlands: Providence, Rhode Island, Brown University, Ph.D. dissertation, 244 p., scale 1:24,000.

Helenek, H. L., and Mose, D. G., 1976, Structure, petrology, and geochronology of the Precambrian rocks in the central Hudson Highlands: New York State Geological Association Guidebook to Field Excursions, 48th Annual Meeting, p. B–1–1—B–1–27.

Henderson, J. R., Tyson, N. S., Wilson, May, and others, 1957a, Aeromagnetic map of the Warwick Quadrangle, Orange County, New York: U.S. Geological Survey Geophysical Investigations Map GP–157, scale 1:31,680.

Henderson, J. R., Tyson, N. S., and others, 1957b, Aeromagnetic map of part of the Hamburg Quadrangle, Sussex County, New Jersey: U.S. Geological Survey Geophysical Investigations Map GP–158, scale 1:31,680.

----1957c, Aeromagnetic map of the Wawayanda and part of the Pine Island Quadrangles, Sussex and Passaic Counties, New Jersey and Orange County, New York: U.S. Geological Survey Geophysical Investigations Map GP–159, scale 1:31,680.

Henderson, J. R., Tyson, N. S., Wilson, May, and others, 1957d, Aeromagnetic map of the Greenwood Lake Quadrangle, Passaic County, New Jersey, and Orange County, New York: U.S. Geological Survey Geophysical Investigations Map GP–160, scale 1:31,680.

Henderson, J. R., Tyson, N. S., and others, 1957e, Aeromagnetic map of part of the Newton East Quadrangle, Sussex County, New Jersey: U.S. Geological Survey Geophysical Investigations Map GP–161, scale 1:31,680.

----1957f, Aeromagnetic map of the Franklin Quadrangle, Sussex and Morris Counties, New Jersey: U.S. Geological Survey Geophysical Investigations Map GP–162, scale 1:31,680.

----1957g, Aeromagnetic map of the Newfoundland Quadrangle, Passaic, Morris, and Sussex Counties, New Jersey: U.S. Geological Survey Geophysical Investigations Map GP–163, scale 1:31,680.

----1957h, Aeromagnetic map of the Wanaque Quadrangle, Passaic and Bergen Counties, New Jersey: U.S. Geological Survey Geophysical Investigations Map GP–164, scale 1:31,680.

Henderson, J. R., Smith, F. C., and others, 1962a, Aeromagnetic map of parts of the Monroe and Maybrook Quadrangles, Orange County, New York: U.S. Geological Survey Geophysical Investigations Map GP–339, scale 1:31,680.

Henderson, J. R., Chandler, E. J., and others, 1962b, Aeromagnetic map of the Ramsey Quadrangle, Passaic and Bergen Counties, New Jersey, and Rockland County, New York: U.S. Geological Survey Geophysical Investigations Map GP–344, scale 1:31,680.

Henderson, J. R., Andreasen, G. E., and Petty, J. A., 1966, Aeromagnetic map of northern New Jersey and adjacent parts of New York and Pennsylvania: U.S. Geological Survey Geophysical Investigations Map GP–562, scale 1:250,000.

Heyl, A. V., 1979, A review of some massive and disseminated sulfide deposits in the northeastern United States [abs.]: Geological Society of America Abstracts with Programs, v. 11, no. 1, p. 16.

Hollowell, J. R., 1971, Hydrology of the Pleistocene sediments in the Wyoming Valley, Luzerne County, Pennsylvania: Pennsylvania Geological Survey Ground-water Report W 28, scale 1:24,000.

Holzwasser, Florrie, 1926, Geology of Newburg and vicinity: New York State Museum and Science Service Bulletin 270, scale 1:62,500.

Hotz, P. E., 1953, Magnetite deposits of the Sterling Lake, New York–Ringwood, New Jersey, area: U.S. Geological Survey Bulletin 982–F, p. 153–244, scale 1:31,680.

Jaffe, H. W., and Jaffe, E. B., 1973, Bedrock geology of the Monroe Quadrangle, New York: New York State Museum and Science Service Map and Chart Series 20, scale 1:24,000.

Jennings, D. S., 1964, Geology of the Flatbrook Valley: Senior thesis on file with New Jersey Geological Survey in Trenton.

Jespersen, Anna, and Griscom, Andrew, 1963, Aeromagnetic interpretation of the geology of the Greenwood Lake and Sloatsburg Quadrangles, New York and New Jersey: U.S. Geological Survey Geophysical Investigations Map GP–311, scale 1:31,680.

Kehn, T. M., Glick, E. E., and Culbertson, W. C., 1966, Geology of the Ransom Quadrangle, Lackawana, Luzerne, and Wyoming Counties, Pennsylvania: U.S. Geological Survey Bulletin 1213, 81 p., scale 1:24,000.

Klemic, Harry, 1962, Uranium occurrences in sedimentary rocks of Pennsylvania: U.S. Geological Survey Bulletin 1107–D, p. 243–288.

Klemic, Harry, Eric, J. H., McNitt, J. R., and McKeown, F. A., 1959a, Uranium in Phillips Mine–Camp Smith area, Putnam and Westchester Counties, New York: U.S. Geological Survey Bulletin 1074–E, p. 165–199.

Klemic, Harry, Heyl, A. V., Taylor, A. R., and Stone, J., 1959b, Radioactive rare earth deposit at Scrub Oaks Mine, Morris County, New Jersey: U.S. Geological Survey Bulletin 1082–B, p. 29–59.

Kothe, K. R., 1960, Structural relations of the Paleozoic rocks in the Schunemunk Quadrangle of southeastern New York: Ithaca, New York, Cornell University, Ph.D. dissertation, 82 p., scale 1:24,000.

Leventhal, J. S., Jennings, J. K., and Lemke, A. J., 1978, Anomalous occurrence of uranium in alpine peats, Summit County, Colorado, and results of a simple fractionation procedure: U.S. Geological Survey Open-File Report 78–235, 48 p.

Lewis, J. V., and Kummel, H. B., 1912, Geologic map of New Jersey: New Jersey Department of Conservation and Economic Development Atlas Sheet 40, scale 1:250,000 [revised 1950 by M. E. Johnson].

LKB Resources, Inc., 1978, NURE aerial gamma-ray and magnetic reconnaissance survey, Thorpe area, Scranton NK18-8 Quadrangle: U.S. Department of Energy Open-File Report GJBX-32(78), 2 v., n.n.p.

Markewicz, F. J., and Dalton, R., 1973, Unpublished map: On file with the New Jersey Geological Survey in Trenton, scale 1:24,000.

Mathews, G. W., 1978, Uranium occurrences in and related to plutonic igneous rocks, *in* Mickle, D. G., and Mathews, G. W., eds., Geologic characteristics of environments favorable for uranium deposits: U.S. Department of Energy Open-File Report GJBX-67(78), p. 121–180.

Maxey, L. R., 1976, Petrology and geochemistry of the Beemerville carbonatite-alkalic complex, New Jersey: Geological Society of America Bulletin, v. 87, p. 1551–1559.

McCauley, J. F., 1961, Uranium in Pennsylvania: Pennsylvania Geological Survey Bulletin M 43, p. 67.

Mickle, D. G., and Mathews, G. W., eds., 1978, Geologic characteristics of environments favorable for uranium deposits: U.S. Department of Energy Open-File Report GJBX-67(78), 250 p.

New Jersey Geological Survey, no date, Unpublished 7.5-minute quadrangle maps: On file with the New Jersey Geological Survey in Trenton, scale 1:24,000.

New York Geological Survey, no date, Unpublished 7.5-minute quadrangle maps: On file with the New York Geological Survey in Albany, scale 1:24,000.

Norman, H. W., 1957, Uranium deposits of northeastern Washington: Mining Engineering, v. 9, no. 6, p. 662–666.

Offield, T. W., 1960, Precambrian portions of the Carmel, Clove, Poughkeepsie, Ramapo, and West Point Quadrangles: New York State Museum and Science Service unpublished maps, scale 1:24,000.

----1967, Bedrock geology of the Goshen–Greenwood Lake area, New York: New York State Museum and Science Service Map and Chart Series 9, 77 p., scale 1:48,000.

Pennsylvania Geological Survey, no date, Unpublished 7.5-minute quadrangle maps: On file with the Pennsylvania Geological Survey in Harrisburg, scale 1:24,000.

Perlmutter, N. M., 1959, Geology and groundwater resources of Rockland County, New York: New York State Power and Control Commission Bulletin GW–42, scale 1:88,700.

Philbin, P. W., and Kirby, J. R., 1964, Aeromagnetic map of the Park Ridge Quadrangle, Bergen County, New Jersey, and Rockland County, New York: U.S. Geological Survey Geophysical Investigations Map GP–494, scale 1:31,680.

Rickard, L. V., 1960, Portions of the Port Jervis, Monticello, Ellenville, Slide Mountain, and Rosendale Quadrangles: New York State Museum and Science Service unpublished maps, scales 1:62,500, 1:31,680, and 1:24,000.

Rose, A. W., 1970, Metal mines and occurrences in Pennsylvania (pt. 3, 1973, reprint), *in* Atlas of Pennsylvania mineral resources: Pennsylvania Geological Survey Bulletin M 50, Fourth Series, 14 p.

----1975, Mode of occurrence of trace elements in soils and stream sediments applied to geochemical exploration, *in* Elliot, I. L., and Fletcher, W. K., eds., Geochemical exploration, 1974: New York, Elsevier Publishing, p. 691–705.

Sanders, J. E., no date, The thickness of Triassic strata, northeastern United States [manuscript]: New York, Barnard College, Columbia University, 86 p.

Saunders, D. F., and Potts, M. J., 1978, Manual for the application of NURE 1974–1977 aerial gamma-ray spectrometer data: U.S. Department of Energy Open-File Report GJBX-13(78), 128 p.

Savage, E. L., 1967, The Triassic rocks of the northern Newark Basin, *in* New York State Geological Association Guidebook: Flushing, New York, p. 49–100.

Schmiermund, R. D., 1977, Geology and geochemistry of uranium deposits near Penn Haven Junction, Carbon County, Pennsylvania: State College, Pennsylvania State University, M.S. thesis, 153 p.

Sevon, W. D., 1975a, Geology and mineral resources of the Hickory Run and Blakeslee Quadrangles, Carbon and Monroe Counties, Pennsylvania: Pennsylvania Geological Survey Fourth Series Atlas 194cd, scale 1:24,000.

----1975b, Geology and mineral resources of the Tobyhanna and Buck Hill Falls Quadrangles, Monroe County, Pennsylvania: Pennsylvania Geological Survey Fourth Series Atlas 204ab, scale 1:24,000.

Sevon, W. D., Rose, A. W., Smith, R. C., II, and Hoff, D. T., 1978, Uranium in Carbon, Lycoming, Sullivan, and Columbia Counties, Pennsylvania: Pennsylvania Geological Survey, Guidebook for the 43th Annual Field Conference of Pennsylvania Geologists, 99 p.

Sims, P. K., 1958, Geology and magnetite deposits of the Dover District, Morris County, New Jersey: U.S. Geological Survey Professional Paper 287, 162 p., scale 1:31,680.

Sims, P. K., and Hotz, P. E., 1951, Zinc-lead deposit at Shawangunk Mine, Sullivan County, New York: U.S. Geological Survey Bulletin 978–D, p. 101–120.

Sims, P. K., and Leonard, B. F., 1952, Geology of the Andover Mining District, Sussex County, New Jersey: New Jersey Department of Conservation and Economic Development Bulletin 62, 46 p., scale 1:1,800.

Smith, B. L., 1969, The Precambrian geology of the central and northeastern parts of the New Jersey Highlands, *in* Subitzky, Seymour, ed., Geology of selected areas in New Jersey and eastern Pennsylvania (and guidebook of excursions): Geological Society of America Annual Meeting, Atlantic City, New Jersey: New Brunswick, New Jersey, Rutgers University Press, p. 35–47.

Smith, R. C., II, 1974, Uranium in the Hardyston Formation: Pennsylvania Geology, v. 5, no. 3, p. 11–12.

----1978, The mineralogy of Pennsylvania 1966–1975: Ephrata, Pennsylvania, Friends of Mineralogy, Pennsylvania Chapter Inc., Special Publication 1, 304 p.

Smith, W. L., Sherwood, A., Riska, D. D., and Hayfield, G. H., 1955, The distribution of uranium in the alkalic rocks of Sussex County, New Jersey: U.S. Geological Survey Trace Element Investigations TEI-503, 11 p.

Spink, W. J., 1966, Stratigraphy and structure of the Paleozoic rocks of northwestern New Jersey: Ph.D. dissertation on file with New Jersey Geological Survey.

Sumner, J. R., 1975, Geophysical interpretation of the structural configuration of the Newark-Gettysburg Triassic Basin: U.S. Geological Survey Open-File Report 76–302, 30 p.

Szalay, A., 1964, Cation exchange properties of humic acids and their importance in the geochemical enrichment of UO_2^{++} and other cations: Geochimica et Cosmochimica Acta, v. 28, p. 1605–1614.

Turner-Peterson, C. E., 1977, Uranium mineralization during early burial, Newark Basin, Pennsylvania–New Jersey, *in* Campbell, J. A., ed., Short papers of the U.S. Geological Survey Uranium-Thorium Symposium, 1977: U.S. Geological Survey Circular 753, p. 3–4.

U.S. Atomic Energy Commission and U.S. Geological Survey, 1968, Preliminary reconnaissance for uranium in Maryland and Pennsylvania, 1953–1957: U.S. Atomic Energy Commission RME–4103, p. 80.

----1969, Preliminary reconnaissance for uranium in Connecticut, Maine, Massachusetts, New Jersey, New York, and Vermont, 1950–1959: U.S. Atomic Energy Commission RME–4106, p. 110.

U.S. Geological Survey, 1969, Aeromagnetic map of the Harrisburg-Scranton area, northeastern Pennsylvania: U.S. Geological Survey Geophysical Investigations Map GP–669, scale 1:250,000

Vine, J. D., 1962, Geology of uranium in coaly carbonaceous rocks: U.S. Geological Survey Professional Paper 356–D, p. 113–170.

Waksman, S. A., Schulhoff, H., Hickman, C. A., Cordon, T. C., Stevens, S. C., 1943, The peats of New Jersey and their utilization, Part B, *of* The peat resources of New Jersey: New Jersey Department of Conservation and Development Bulletin 55, 278 p.

Way, J. H., Jr., 1972, A more detailed discussion of the depositional environmental analysis, Middle and Upper Devonian sedimentary rocks, Catskill Mountain area, New York: Troy, New York, Rensselaer Polytechnic Institute, Ph.D. dissertation, 125 p.

Woodrow, D. L., 1968, Portions of the LeRaysville, Montrose and Susquehanna Quadrangles: New York Geological Survey unpublished maps on file in Albany, scale 1:62,500.

Woodrow, D. L., and Fletcher, F. W., 1968, Facies and the Rhinestreet Formation in south central New York, *in* New York State Geological Association Guidebook: Binghamton, New York, scale 1:250,000.

Young, D. A., 1978, Precambrian salic intrusive rocks of the Reading Prong: Geological Society of America Bulletin, v. 89, p. 1502–1514.

Zartman, R. E., Brock, M. R., Heyl, A. V., and Thomas, H. H., 1967, K–Ar and Rb–Sr ages of some alkalic intrusive rocks from central and eastern United States: American Journal of Science, v. 265, p. 848–870.

APPENDIX A. URANIUM OCCURRENCES IN THE SCRANTON QUADRANGLE

Occurrence No.	Name	Location		Host rock	Deposit class* or subclass (No.)	Production[†]	Reference[#]
		Lat. (N)	Long. (W)				
1	Glen Wild 1	41 40 13	74 36 43	Catskill Fm.	Sandstone (243)	a	RME-4106 Baillieul & Indelicato, 1978
2	Glen Wild 2	41 39 03	74 37 20	Catskill Fm.	Sandstone (243)	a	RME-4106 Baillieul & Indelicato, 1978
3	Glen Wild 3	41 39 09	74 35 24	Catskill Fm.	Sandstone (243)	a	RME-4106 Baillieul & Indelicato, 1978
4	Glen Wild 4	41 39 44	74 36 12	Catskill Fm.	Sandstone (243)	a	RME-4106 Baillieul & Indelicato, 1978
5	Glen Wild 5	41 39 11	74 33 16	Catskill Fm.	Sandstone (243)	a	Baillieul & Indelicato, 1978
6	Glen Wild 6	41 40 19	74 33 16	Catskill Fm.	Sandstone (243)	a	Baillieul & Indelicato, 1978
7	Glen Wild 7	41 39 40	74 33 22	Catskill Fm.	Sandstone (243)	a	Baillieul & Indelicato, 1978
8	Glen Wild 8	41 38 22	74 37 35	Catskill Fm.	Sandstone (243)	a	Baillieul & Indelicato, 1978
9	Glen Wild 9	41 37 20	74 35 26	Catskill Fm.	Sandstone (243)	a	Baillieul & Indelicato, 1978
10	Bethel	41 41 26	74 54 05	Catskill Fm.	Sandstone (243)	a	This report
11	Millen Farm	41 32 03	75 28 16	Catskill/Duncannon	Sandstone (243)	a	RME-4103 Klemic, 1962 McCauley, 1961
X12	Mt. Cobb	41 24 39	75 30 29	Catskill/Duncannon	Sandstone (243)	a	McCauley, 1961
13	Laurel Run	41 12 45	75 51 05	Pocono Fm.	Sandstone (243)	a	RME-4103 Klemic 1962
14	Penn. Turnpike 1	41 03 09	75 40 36	Spechty Kopf	Sandstone (243)	a	RME-4103 Klemic, 1962
15	Rutan Hill	41 14 45	74 40 35	Beemerville complex	Orthomagmatic (310)	a	Smith, et al, 1955 Maxey, 1976
16	Beemerville Nepheline Syenite Complex	41 13 25	74 42 26	Beemerville complex	Orthomagmatic (310)	a	Smith et al, 1955 Maxey, 1976
17	Clove Mine	41 18 51	74 12 02	Amphibolite in amphibolite gneiss	Contact metasomatic (340)	a	RME-4106 Colony, 1921 Jaffe, 1973
18	Mombasha Mine	41 17 23	74 12 36	Leucogranodiorite	Contact metasomatic (340)	a	RME-4106 Colony, 1921 Jaffe, 1973
19	Sterling Forest	41 14 37	74 12 27	Calc-silicate gneiss	Contact metasomatic (340)	a	This report
20	Rock Hill	41 13 49	74 21 26	Contact of leucogranite and quartz-feldspar gneiss	Anatectic (380)	a	This report
21	Miles Standish Mine	41 13 34	74 20 36	Amphibolite in amphibolite gneiss	Magmatic hydrothermal (330)	a	RME-4106 Offield, 1967 EMJ, 1957
22	Raynor Mine	41 13 10	74 20 42	Amphibolite in amphibolite gneiss	Magmatic hydrothermal (330)	a	RME-4106 Offield, 1967
23	Bowen Road	41 12 56	74 22 20	Leucogranite	Anatectic (380)	a	This report
24	Centennial Mine	41 11 35	74 22 02	Amphibolite gneiss	Magmatic hydrothermal (330)	a	RME-4106 Bayley, 1910
25	Longhouse Brook	41 11 30	74 22 20	Amphibolite gneiss	Contact metasomatic (340)	a	This report
26	Ringwood District	41 08 46	74 16 07	Amphibolite	Contact metasomatic (340)	a	RME-4106 Hotz-1953
27	Bowling Green Mtn.	41 00 19	74 32 00	Leucogranite & pegmatite	Pegmatitic (320)	a	RME-4106 Buddington & Baker, 1961
28	Edison Mine Group	41 03 47	74 34 19	Quartz-feldspar gneiss	Contact metasomatic (340)	a	PRR M-1511, PRR M-1512
29	Andover Mine	41 00 14	74 44 08	Sheared granite	Authigenic (360)	a	RME-4106 Sims & Leonard, 1952
30	Mount Peter	41 14 29	74 17 47	Diorite gneiss	Contact metasomatic (340)	a	This report

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* Deposit classes from Mickle and Mathews, eds. (1978)

† Production categories:
a. 0 - 20,000 lb U_3O_8
b. 20,000 - 200,000 lb U_3O_8
c. 200,000 - $2x10^6$ lb U_3O_8
d. $2x10^6$ - $2x10^7$ lb U_3O_8
e. greater than $2x10^7$ lb U_3O_8

RME, PRR: U.S. Atomic Energy Commission Raw Materials Exploration and Preliminary Reconnaissance Reports, open filed

X Occurrence looked for, but not found; may be concealed by recent road construction.

APPENDIX B. TABLE OF CHEMICAL ANALYSES, SCRANTON

Sample Number	Geologic Code (Pl. 7)	cU_3O_8 (ppm)	Ag (ppm)	Al (ppm)	As (ppm)	B (ppm)	Ba (ppm)	Be (ppm)	Ca (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Fe (ppm)	La (ppm)	Li (ppm)	Mn (ppm)	Mo (ppm)	Na (ppm)	Nb (ppm)	Ni (ppm)	Pb (ppm)	Sb (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ti (ppm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
MHI 536	qtcs	1	N	70,000	N	100	500	10	7,000	10	50	15	30,000	150	N	700	N	10,000	10	5	30	N	20	N	100	3,000	50	N	70	N	100
537	Om	3	N	70,000	N	100	700	15	50,000	15	70	20	30,000	100	N	700	5	15,000	10	30	70	N	15	N	500	3,000	50	N	30	N	100
538	Ss	2.5	N	60,000	N	100	700	10	2,000	15	70	7,000	15,000	100	N	100	N	10,000	10	30	10	N	15	N	100	3,000	50	N	20	N	200
539	Ss	3	N	70,000	N	150	700	15	2,000	15	50	150	30,000	100	N	300	N	10,000	10	30	10	N	20	N	100	5,000	50	N	20	N	300
540	Ss	1	N	10,000	N	N	50	2	L	N	50	20	5,000	20	N	20	N	N	N	N	10	N	N	N	100	2,000	10	N	10	N	200
MHI 541	fm	1	N	10,000	N	N	100	2	200,000	N	10	N	700	50	N	100	N	2,000	N	N	10	N	N	N	2,000	200	L	N	20	N	N
542	am	29.5	L	60,000	N	50	150	10	100,000	20	70	50	30,000	N	N	100	10	10,000	10	20	N	N	30	N	700	3,000	100	N	20	200	50
543	Om	3	N	70,000	N	50	500	10	5,000	20	70	30	20,000	50	N	200	N	10,000	10	30	10	N	15	N	100	2,000	70	N	20	N	100
544	Om	1.5	N	70,000	N	50	300	10	7,000	10	70	20	20,000	50	N	200	N	10,000	10	30	10	N	15	N	100	3,000	70	N	20	N	150
545	Ss	1	N	20,000	N	N	50	2	500	N	10	N	3,000	N	N	10	N	N	N	N	10	N	N	N	100	1,500	10	N	10	N	100
MHI 546	Om	3	N	70,000	N	50	500	10	10,000	10	70	30	30,000	50	N	300	N	10,000	10	30	30	N	15	N	100	2,000	50	N	10	N	50
547	Ss/Om	2	0.5	30,000	N	20	100	5	500	10	10	70	10,000	50	N	N	N	1,500	20	N	50	N	N	N	100	2,000	10	N	L	N	700
548	Sbm	2.5	N	70,000	N	200	700	15	20,000	20	70	L	30,000	100	N	70	N	7,000	20	30	10	N	15	N	100	3,000	70	N	20	N	200
549	Ꞓh	2	N	70,000	N	20	700	15	2,000	10	20	20	20,000	100	N	20	N	20,000	20	10	30	N	10	N	100	2,000	30	N	70	N	300
550	Ꞓh	2	N	70,000	N	20	700	15	2,000	N	20	20	20,000	150	N	10	N	20,000	20	N	50	N	10	N	100	3,000	30	N	70	N	500
MHI 551	am/mt	550	N	30,000	N	50	100	30	50,000	30	20	500	70,000	1,000	N	500	N	15,000	10	10	500	N	10	N	100	500	30	N	70	L	200
552	am	49	N	30,000	N	100	50	15	50,000	30	20	300	150,000	1,000	N	500	N	10,000	50	N	N	N	N	N	100	500	30	N	10	200	50
553	amg	210	N	70,000	N	20	700	15	30,000	20	20	100	50,000	1,000	N	100	N	30,000	20	N	100	N	N	N	500	300	20	N	70	N	50
554	am	50	N	30,000	N	200	100	15	100,000	30	20	70	50,000	1,000	N	700	N	10,000	10	N	10	N	N	N	200	500	30	N	20	L	70
555	amg/mt	55	N	40,000	N	50	50	15	20,000	150	20	700	100,000	500	N	100	N	20,000	20	50	N	N	N	N	100	500	20	N	10	N	70
MHI 556	Dsk	1	N	20,000	N	N	50	2	20.000	10	10	50	10,000	50	N	200	N	1,500	N	N	10	N	N	N	100	500	20	N	150	N	50
557	am/mt	7	N	10,000	N	50	N	10	50,000	100	50	7	100,000	200	N	500	N	5,000	L	20	10	N	30	N	100	1,000	200	N	150	L	N
558	am/mt	1	N	40,000	N	50	50	10	50,000	30	200	10	50,000	50	N	500	N	15,000	10	100	10	N	70	N	100	2,000	100	N	150	N	50
559	mt	1	N	10,000	N	100	50	2	15,000	20	20	L	150,000	200	N	200	N	15,000	10	30	N	N	10	N	100	500	300	N	15	300	N
560	g	13	N	50,000	N	N	50	5	3,000	N	N	10	5,000	20	N	50	N	30,000	N	N	50	N	N	N	1,000	100	L	N	20	N	N
MHI 561	am	90	N	60,000	N	100	1,500	15	70,000	30	70	10	50,000	200	N	2,000	N	20,000	L	N	50	N	15	N	200	1,000	50	N	150	200	N
562	am/mt	2	N	20,000	N	100	20	15	10,000	50	20	L	150,000	50	N	1,000	N	N	10	50	N	N	10	N	N	1,000	200	N	50	500	N
563	am/at	1	N	10,000	N	100	100	10	10,000	30	50	20	150,000	50	N	700	N	15,000	10	50	N	N	15	N	200	1,000	200	N	50	300	N
564	al	21	N	70,000	N	10	700	15	7,000	10	10	L	30,000	500	N	100	5	30,000	50	N	50	N	10	N	200	1,500	20	N	150	N	300
565	al	3	N	70,000	N	N	700	7	5,000	N	N	10	7,000	100	N	70	N	30,000	N	N	70	N	N	N	200	500	L	N	N	N	50
MHI 566	hg	3	N	70,000	N	N	700	15	7,000	N	N	L	20,000	300	N	100	N	30,000	20	N	30	N	5	N	100	1,500	N	N	100	N	200
568	gd	115	N	50,000	N	50	150	50	7,000	10	50	70	50,000	700	N	3,000	N	10,000	50	10	50	N	30	N	100	1,500	30	N	200	N	1,000
569	gnp	60	N	70,000	N	N	1,000	10	3,000	N	10	15	15,000	100	N	70	N	30,000	L	N	70	N	N	L	100	500	L	N	30	N	100
570	gnm	5	N	40,000	N	20	700	L	1,000	20	10	70	70,000	300	N	300	N	7,000	20	N	10	N	15	N	100	5,000	50	N	50	200	700
571	gnm	1	N	60,000	N	100	1,000	N	5,000	100	20	50	100,000	100	N	3,000	10	5,000	20	30	N	N	50	L	N	5,000	70	N	20	700	50
MHI 572	g	4	N	70,000	N	10	700	10	10,000	L	10	7	15,000	700	N	300	L	30,000	10	N	70	N	N	N	500	2,000	10	N	10	N	N
573	gnm	2	N	70,000	N	100	700	15	15,000	20	20	10	50,000	150	N	1,500	L	5,000	20	N	N	N	20	L	100	5,000	30	N	100	500	50
574	gnm	49	N	70,000	N	20	5,000	N	30,000	50	20	700	70,000	700	N	1,000	200	15,000	50	15	10	N	5	20	500	2,000	20	N	200	300	500
575	sk	1	N	40,000	N	100	700	7	100,000	200	20	500	150,000	150	N	1,000	50	5,000	10	70	100	N	5	N	300	1,000	20	N	70	700	50
576	Oj	1	N	300,000	N	10	150	2	200,000	N	20	7	7,000	150	N	700	N	5,000	N	L	10	N	5	N	1,500	1,500	15	N	10	N	100
MHI 577	Om	1	N	70,000	N	100	700	15	50,000	20	70	50	30,000	100	N	1,500	L	20,000	10	50	50	N	15	N	500	3,000	50	N	50	N	100
578	Om	2	N	60,000	N	100	700	15	5,000	20	70	30	20,000	100	N	500	N	20,000	10	50	30	N	15	N	100	3,000	50	N	20	N	300
579	Om	1	N	60,000	N	20	200	7	30,000	L	50	15	15,000	50	N	700	N	15,000	10	20	20	N	10	N	300	3,000	30	N	30	N	300
580	Om	3	N	60,000	N	100	700	20	20,000	15	70	30	20,000	150	N	300	N	10,000	10	50	20	N	20	N	100	3,000	50	N	30	N	300
581	Om	1	N	70,000	N	100	700	20	30,000	20	100	50	30,000	100	N	500	N	20,000	10	50	30	N	20	N	200	3,000	50	N	30	200	100
MHI 582	Om	3	N	70,000	N	100	700	20	3,000	15	70	50	30,000	100	N	500	N	20,000	10	50	70	N	15	L	100	3,000	50	N	20	200	100
585	Om	2	N	70,000	N	100	700	20	30,000	10	70	50	30,000	100	N	1,500	N	20,000	10	50	30	N	15	N	500	3,000	50	N	20	L	100
586	Om	2	N	70,000	N	100	700	20	7,000	20	100	50	30,000	100	N	1,000	N	20,000	10	50	50	N	30	L	100	3,000	50	N	30	L	200
587	Om	1	N	10,000	N	N	50	5	60,000	N	10	5	30,000	N	N	200	N	1,500	N	N	10	N	N	N	700	500	10	N	L	N	N
588	Ohl	4	N	70,000	N	100	700	20	10,000	20	100	50	30,000	100	N	1,500	N	20,000	10	50	30	N	30	L	200	3,000	50	N	50	L	200
MHI 589	Q	-	N	70,000	N	100	700	15	50,000	15	70	30	20,000	100	N	1,000	5	10,000	10	30	30	N	15	N	300	2,000	30	N	30	L	100
590	Ob	1	N	40,000	N	10	200	5	150,000	N	20	10	10,000	50	N	200	5	2,000	N	N	L	N	5	N	N	1,500	20	N	20	N	100
591	Ob	1	N	10,000	N	10	50	2	200,000	N	10	L	5,000	20	N	300	N	1,500	N	N	L	N	N	N	N	200	10	N	L	N	N
592	Om	2	N	60,000	N	100	700	15	10,000	20	50	30	30,000	50	N	500	N	20,000	10	50	30	N	15	N	200	3,000	30	N	50	200	500
593	Om	2	N	60,000	N	100	700	15	30,000	20	70	50	30,000	100	N	700	N	15,000	10	50	20	N	20	N	100	3,000	60	N	70	L	200

APPENDIX B. TABLE OF CHEMICAL ANALYSES, SCRANTON (Continued)

Sample Number	Geologic code (Pl. 7)	cU_3O_8 (ppm)	Ag (ppm)	Al (ppm)	As (ppm)	B (ppm)	Ba (ppm)	Be (ppm)	Ca (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Fe (ppm)	La (ppm)	Li (ppm)	Mn (ppm)	Mo (ppm)	Na (ppm)	Nb (ppm)	Ni (ppm)	Pb (ppm)	Sb (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ti (ppm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
MHI 594	Ss	1	L	30,000	N	N	100	2	700	N	10	15	5,000	50	N	20	N	1,500	10	N	30	N	N	N	100	1,500	10	N	10	N	200
595	Om	1	L	60,000	N	100	700	20	1,500	15	70	70	30,000	100	N	200	N	5,000	10	50	20	N	20	N	100	3,000	50	N	50	N	200
596	Om	1	5	30,000	N	20	150	7	700	15	10	50	10,000	50	N	20	N	N	10	N	500	N	N	N	L	1,500	20	N	10	10,000	100
597	Om	5	N	70,000	N	100	700	15	7,000	20	100	50	30,000	100	N	700	N	15,000	10	50	70	N	15	N	100	3,000	50	N	30	500	100
598	Om	3	N	70,000	N	100	700	20	1,000	20	100	50	30,000	100	N	700	N	15,000	10	50	70	N	20	N	100	3,000	70	N	20	500	100
MHI 599	Om	3	N	70,000	N	100	700	20	7,000	20	100	50	30,000	100	N	1,000	N	15,000	10	50	70	N	20	N	100	3,000	70	N	30	200	100
600	Om	3	N	70,000	N	100	700	20	2,000	20	100	50	30,000	100	N	700	N	15,000	10	50	50	N	15	N	100	3,000	70	N	20	L	100
601	Om	1	N	70,000	N	100	500	15	15,000	20	70	30	20,000	50	N	1,000	N	15,000	10	50	50	N	15	N	200	3,000	50	N	20	L	100
602	P	26	N	70,000	N	50	5,000	30	3,000	N	10	7	20,000	150	N	700	N	20,000	300	N	30	N	N	10	700	2,000	20	N	20	200	100
603	d	3	N	70,000	N	20	700	50	50,000	15	50	20	30,000	300	N	2,000	5	30,000	100	10	20	N	15	N	1,000	7,000	50	N	70	200	700
MHI 604	d	7	N	40,000	N	50	1,500	15	50,000	20	10	10	50,000	200	N	3,000	10	15,000	100	N	N	N	15	N	1,500	10,000	70	N	70	300	1,000
605	ns	4	N	70,000	N	20	2,000	20	20,000	10	10	30	30,000	200	N	1,500	5	40,000	100	N	10	N	10	N	2,000	7,000	70	N	70	N	700
606	ns	3	N	70,000	N	10	1,000	15	15,000	N	10	30	20,000	50	N	700	N	40,000	50	N	10	N	N	N	1,500	3,000	50	N	20	N	300
607	Om	3	N	70,000	N	100	700	20	30,000	20	100	30	30,000	100	N	500	N	15,000	10	50	30	N	15	N	200	3,000	50	N	30	N	200
608	Om	2	N	70,000	N	100	700	20	3,000	20	100	50	30,000	50	N	300	N	15,000	10	30	20	N	15	L	100	2,000	50	N	20	N	50
MHI 609	Om	1	N	60,000	N	100	500	10	50,000	10	50	30	20,000	100	N	700	N	10,000	N	30	50	N	15	N	700	2,000	50	N	20	N	100
610	Ob	1	N	20,000	N	10	100	5	150,000	N	10	L	5,000	50	N	200	N	2,000	N	N	L	N	N	N	100	1,000	15	N	10	N	20
611	Oj	1	N	40,000	N	N	150	7	20,000	N	20	20	10,000	50	N	300	N	10,000	N	L	L	N	5	N	2,000	2,000	20	N	20	N	200
612	Om	2	N	60,000	N	100	500	10	15,000	15	70	50	20,000	50	N	1,000	N	10,000	10	30	30	N	15	N	200	3,000	50	N	20	200	20
613	Oqu	2	N	50,000	N	20	500	5	30,000	10	50	15	15,000	20	N	500	N	10,000	N	20	10	N	10	N	200	2,000	30	N	10	N	70
MHI 614	Om	2	N	70,000	N	100	500	15	2,000	20	70	30	30,000	50	N	700	N	10,000	N	50	50	N	15	N	L	2,000	50	N	10	L	50
615	Om	3	N	70,000	N	100	700	15	7,000	15	70	30	20,000	100	N	300	N	10,000	N	30	30	N	15	N	100	3,000	50	N	20	N	100
616	am/mt	100	N	10,000	N	100	20	3	5,000	L	20	50	100,000	500	N	200	N	20,000	10	N	10	N	5	N	N	2,000	50	N	20	300	N
617	am/mt	350	N	40,000	N	20	150	20	2,000	10	20	100	70,000	700	N	200	N	20,000	10	N	70	N	5	N	100	1,500	30	N	20	N	200
618	mt	75	N	40,000	N	50	50	20	30,000	70	20	100	100,000	1,000	N	500	N	50,000	10	15	N	N	N	N	100	1,500	30	N	100	200	300
MHI 619	gp	2	N	70,000	N	10	2,000	15	7,000	N	N	50	10,000	100	N	100	N	30,000	N	N	10	N	N	N	700	500	10	N	10	N	N
620	gd	4	N	50,000	N	10	700	30	50,000	10	10	20	50,000	50	N	500	N	20,000	10	N	10	N	N	N	100	1,500	10	N	30	N	200
621	mt	14	N	L	N	50	700	20	30,000	15	10	10	70,000	100	N	700	N	20,000	20	N	N	N	5	N	100	1,000	10	N	70	L	300
622	mt	2	N	-	N	50	1,000	2	1,000	30	20	70	150,000	150	N	700	5	7,000	30	N	N	N	N	N	N	100	10	N	70	500	N
623	gd	55	N	70,000	N	50	700	20	3,000	15	10	70	50,000	700	N	300	N	20,000	20	N	30	N	5	N	700	2,000	30	N	20	N	100
MHI 624	hfg	21	N	70,000	N	50	1,500	20	50,000	15	10	15	20,000	500	N	500	5	20,000	10	L	10	N	10	N	700	3,000	30	N	50	N	200
625	qfg	215	N	70,000	N	10	1,500	10	15,000	15	20	20	30,000	150	N	300	N	20,000	10	10	100	N	10	N	500	30,000	30	N	50	N	100
626	cont	405	N	70,000	N	20	700	5	15,000	15	150	20	30,000	G1,000	N	700	N	15,000	20	15	500	N	20	N	100	50,000	70	N	G200	N	300
627	al	2	N	70,000	N	N	1,500	5	3,000	N	N	L	7,000	150	N	100	N	20,000	N	N	50	N	N	N	700	1,500	10	N	10	N	N
628	cont	130	N	70,000	N	20	700	7	20,000	15	150	30	30,000	G1,000	N	200	N	20,000	20	20	200	N	15	N	300	5,000	100	N	G200	N	200
MHI 629	qfg	3	N	30,000	N	10	150	2	1,500	N	10	10	10,000	50	N	300	N	10,000	N	L	10	N	5	N	700	20,000	20	N	20	N	100
630	am	1	N	60,000	N	20	500	20	70,000	30	150	70	30,000	100	N	700	N	20,000	10	70	N	N	20	N	100	2,000	50	N	50	N	50
631	Dbv	3	N	60,000	N	100	300	15	1,500	15	70	30	20,000	100	N	100	N	30,000	10	50	10	N	10	N	700	3,000	50	N	30	N	700
632	gao	4	N	70,000	N	N	700	5	3,000	N	10	L	10,000	100	N	30	N	20,000	N	N	20	N	N	N	100	700	N	N	N	N	N
633	hg	21	N	60,000	N	N	500	10	5,000	N	N	5	10,000	300	N	70	N	20,000	10	N	70	N	N	N	200	1,000	N	N	20	N	50
MHI 634	hg	9	N	60,000	N	N	300	20	5,000	N	N	10	10,000	150	N	70	N	20,000	20	N	20	N	N	N	100	1,000	N	N	20	L	20
635	Ss	1	7	10,000	N	20	50	2	L	100	N	150	20,000	20	N	30	N	N	N	N	5,000	N	N	N	100	200	L	N	N	G10,000	50
636	Ss	1	N	20,000	N	N	20	5	L	N	N	5	3,000	20	N	10	N	1,500	10	N	100	N	N	N	100	300	10	N	L	1,000	50
637	Dck	39	1	47,000	34	135	360	14	12,500	13	57	760	18,300	13	30	2,010	7	5,900	6	27	43	14	3	1	100	1,640	120	7	19	215	33
638	Dck	880	27	46,800	240	150	1,300	19	8,100	20	165	13,100	24,500	17	45	1,870	23	6,200	13	31	120	42	4	7	100	2,130	465	100	210	275	49
MHI 639	Dck	1,530	77	42,900	330	135	510	13	9,250	25	180	32,200	15,700	21	50	1,200	93	4,450	16	28	330	58	5	10	100	2,180	1,480	185	200	345	44
640	Dck	4	1	62,400	70	155	375	26	1,470	22	75	94	36,000	39	35	580	13	5,300	31	34	42	25	7	10	110	4,340	85	47	11	190	105
641	Dck	2,880	36	55,900	490	150	3,323	35	1,130	25	245	840	45,300	9	75	1,190	24	5,600	13	81	145	28	4	9	100	1,740	215	75	52	265	37
642	Dck	1,060	4	57,800	380	155	995	20	1,840	18	145	145	23,400	16	75	460	20	7,400	16	27	255	28	6	8	100	2,390	645	54	320	200	50
643	Dck	3	1	46,200	56	165	195	15	815	8	51	2	22,300	11	15	360	8	7,400	2	19	23	13	2	1	100	1,110	35	34	3	195	25
MHI 644	Dck	2,760	14	62,500	780	135	1,380	14	1,170	19	215	4,310	18,200	14	60	425	160	7,000	9	42	2,020	125	4	1	100	1,560	720	41	68	325	42
645	Dck	3	1	58,200	105	150	365	14	13,600	15	59	76	19,600	19	30	1,070	11	7,800	10	29	33	33	4	6	100	2,180	58	73	8	255	39
646	Dck	6	1	73,800	63	150	400	25	1,350	23	74	52	33,700	28	30	540	13	5,900	24	36	56	31	7	10	100	3,750	145	37	9	270	60
647	Dck	390	1	74,100	135	150	545	17	1,390	21	155	115	21,200	33	50	450	25	6,600	35	29	145	42	8	11	100	4,560	370	61	43	210	150
648	Dck	540	1	69,200	155	150	1,120	22	1,160	23	145	36	29,800	22	55	490	22	7,000	20	42	317	44	7	8	100	3,190	430	49	45	240	72

APPENDIX B. TABLE OF CHEMICAL ANALYSES, SCRANTON (Continued)

Sample Number	Geologic Code (Pl. 7)	cU_3O_8 (ppm)	Ag (ppm)	Al (ppm)	As (ppm)	B (ppm)	Ba (ppm)	Be (ppm)	Ca (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Fe (ppm)	La (ppm)	Li (ppm)	Mn (ppm)	Mo (ppm)	Na (ppm)	Nb (ppm)	Ni (ppm)	Pb (ppm)	Sb (ppm)	Sc (ppm)	Sn (ppm)	Sr (ppm)	Ti (ppm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
MHI 001	Dck	4	N	70,000	N	100	1,000	30	1,500	15	150	5	50,000	150	N	100	N	10,000	20	50	20	N	30	N	100	5,000	50	N	70	N	100
002	Dck	140	N	20,000	N	10	300	15	L	10	10	20	15,000	20	N	700	N	1,500	10	7	70	N	N	N	100	2,000	20	N	10	N	200
026	Dck	140	70	70,000	N	20	500	15	2,000	20	50	10,000	20,000	150	N	300	5	15,000	30	15	30	N	15	N	100	5,000	200	N	50	N	500
027	Dck	89	10	70,000	N	20	700	30	2,000	15	50	3,000	15,000	150	N	300	N	20,000	10	15	50	N	15	N	200	7,000	500	N	20	N	700
028	Dck	5	N	70,000	N	50	700	30	2,000	20	100	20	30,000	150	N	300	N	10,000	30	50	30	N	30	L	200	5,000	700	N	70	N	300
MHI 030	Dck	58	3	70,000	300	20	700	30	2,000	15	50	1,500	15,000	100	N	700	N	20,000	20	20	70	N	15	N	100	7,000	30	N	20	N	700
031	Dck	70	N	70,000	N	20	700	20	30,000	15	50	20	15,000	100	N	5,000	N	20,000	10	20	20	N	10	N	200	3,000	20	N	20	L	300
032	Dck	240	N	70,000	N	20	1,500	30	2,000	10	30	150	20,000	20	N	700	N	15,000	10	10	70	N	5	N	100	2,000	50	N	70	N	100
033	Dck	3,200	N	70,000	1,000	20	1,500	30	2,000	15	10	15	30,000	50	N	1,000	N	15,000	10	10	100	N	5	N	200	3,000	50	N	150	N	300
034	Dck	88	N	70,000	N	20	700	30	2,000	15	50	15	30,000	50	N	1,000	N	20,000	10	15	70	N	10	N	100	5,000	50	N	20	L	200
MHI 035	Dck	100	N	70,000	N	20	500	20	2,000	10	30	100	20,000	150	N	200	N	20,000	10	15	200	N	10	N	100	5,000	50	N	20	N	300
036	Dck	1,500	5	70,000	200	20	700	30	2,000	15	70	150	20,000	150	N	300	N	20,000	20	20	200	N	30	N	100	7,000	500	N	7,200	N	700
037	Dck	6	N	70,000	N	20	2,000	15	10,000	15	50	20	20,000	100	N	1,000	N	10,000	10	20	70	N	10	N	200	3,000	30	N	10	N	200
038	Dck	7	L	70,000	N	100	500	15	2,000	15	70	2,000	20,000	150	N	200	N	15,000	30	20	50	N	30	N	100	7,000	50	N	50	N	700
039	Dck	2	N	70,000	N	10	1,500	10	30,000	10	20	15	15,000	50	N	3,000	N	15,000	10	10	20	N	5	N	200	2,000	20	N	20	N	300
MHI 040	Dck	3	N	70,000	N	10	1,000	30	30,000	10	10	70	15,000	100	N	5,000	N	15,000	10	15	30	N	N	N	100	2,000	20	N	100	N	100
041	Dck	3	N	60,000	N	50	500	10	1,500	10	50	50	20,000	100	N	100	N	5,000	20	20	20	N	15	N	100	7,000	30	N	20	N	1,000
042	Mdsck	4	N	70,000	N	50	500	10	700	15	70	15	30,000	100	N	300	N	5,000	10	20	20	N	15	N	100	3,000	30	N	20	N	100
043	Dck	180	2	70,000	N	20	500	15	3,000	15	70	70	20,000	100	N	700	N	15,000	20	20	700	N	20	N	100	7,000	1,500	N	150	N	700
044	am/mt	66	N	10,000	N	20	20	5	7,000	15	20	500	150,000	300	N	200	N	N	150	N	N	N	N	N	N	500	30	N	20	500	N
MHI 501	Om	1	N	10,000	N	10	100	2	150,000	N	10	10	10,000	50	N	200	N	2,000	N	5	N	N	N	N	100	300	10	N	N	N	N
502	Q^1	5	1	30,000	N	20	150	10	10,000	N	20	20	10,000	100	N	300	N	5,000	N	5	70	N	10	10	N	2,000	50	N	20	N	70
503	Q^1	2	1	50,000	N	N	50	2	7,000	N	10	N	500	50	N	N	N	1,500	N	N	N	N	N	N	N	20	N	N	N	N	N
504	Q^2	2	N	30,000	N	10	100	3	200,000	N	10	15	15,000	50	N	300	N	5,000	N	N	10	N	5	N	700	1,500	20	N	10	N	100
505	Om	1	N	10,000	N	N	100	5	150,000	N	10	7	7,000	50	N	200	N	2,000	N	L	N	N	N	N	100	500	10	N	10	L	50
MHI 506	Q^2	3.5	N	50,000	N	50	200	10	20,000	10	30	20	15,000	100	N	500	N	10,000	10	20	20	N	10	N	100	3,000	50	N	20	N	100
507	Q^1	3	N	20,000	N	10	100	5	7,000	N	10	15	10,000	50	N	70	5	2,000	N	5	70	N	N	50	N	1,000	20	N	10	N	50
508	Q^2	2	N	70,000	N	50	300	10	10,000	20	70	20	20,000	100	N	200	7	10,000	20	30	30	N	15	N	100	3,000	70	100	300	N	300
509	Q^1	1	N	20,000	N	10	150	10	15,000	N	10	15	7,000	100	N	100	N	2,000	N	N	10	N	5	N	N	1,000	20	N	30	N	70
510	rbqf	1	N	70,000	N	10	500	15	20,000	L	10	5	20,000	20	N	200	N	20,000	N	L	10	N	N	N	100	500	10	N	10	N	50
MHI 511	rbqf	1	N	70,000	N	10	200	7	30,000	20	20	20	30,000	N	N	300	N	20,000	10	30	N	N	15	N	700	2,000	50	N	10	N	N
512	Q^1	6.5	N	50,000	N	20	150	10	7,000	10	50	100	10,000	100	N	200	N	10,000	N	50	50	N	15	20	100	1,500	50	N	70	N	70
513	Q^1	1.5	N	20,000	N	10	150	7	15,000	N	10	15	5,000	50	N	200	N	5,000	N	L	L	N	5	N	N	1,000	20	N	10	N	50
514	–	460	N	60,000	N	100	300	20	10,000	10	10	15	50,000	300	N	200	N	20,000	10	70	70	N	N	N	200	2,000	20	N	10	N	500
515	Q^1	335	N	40,000	N	20	150	20	7,000	10	20	30	10,000	100	N	100	N	10,000	N	70	70	N	10	10	100	300	50	N	50	N	300
MHI 516	Q^1	4.5	N	20,000	N	10	100	5	15,000	N	10	15	3,000	50	N	50	N	2,000	N	L	L	N	N	L	N	1,000	10	N	10	N	50
517	Ob	1.5	0.5	20,000	N	N	150	2	150,000	N	10	5	5,000	20	N	200	N	2,000	N	N	N	N	5	N	100	1,000	10	N	10	N	50
518	hg	1	N	70,000	N	20	1,500	15	10,000	N	N	10	20,000	300	N	100	N	20,000	10	N	20	N	5	N	700	1,000	10	N	20	N	100
519	Q^1	15	N	50,000	N	50	200	15	3,000	10	50	30	10,000	150	N	300	N	10,000	N	20	70	N	15	20	100	300	70	N	70	N	200
520	Mp	1	N	50,000	N	100	700	15	20,000	15	70	30	20,000	100	N	700	N	10,000	10	30	20	N	15	N	300	300	30	N	30	N	200
MHI 521	Q^1	5	N	20,000	N	N	150	10	5,000	N	10	20	5,000	100	N	50	N	5,000	N	10	30	N	10	10	N	1,500	30	N	70	N	100
522	Mmc	3	N	70,000	N	100	700	15	30,000	20	100	30	30,000	100	N	1,000	N	15,000	10	50	20	N	15	N	500	5,000	30	N	30	N	200
523	Mp	2	N	10,000	N	N	20	2	700	N	N	15	7,000	N	N	10	N	L	N	N	10	N	N	N	100	300	L	N	N	N	N
524	Dcpp	2	N	50,000	N	50	200	10	2,000	10	50	L	20,000	100	N	200	N	5,000	5,000	20	10	N	10	N	100	5,000	20	N	20	N	100
525	Q^1	4	N	20,000	N	N	200	10	2,000	N	10	20	5,000	100	N	100	N	2,000	N	20	10	N	5	N	N	1,500	20	N	70	N	50
MHI 526	Q^2	7	N	40,000	N	50	150	10	1,500	10	20	15	15,000	100	N	300	N	7,000	20	15	30	N	10	N	100	5,000	30	N	30	N	300
527	Q^1	1	N	5,000	N	N	100	2	5,000	N	N	N	500	50	N	50	N	1,500	N	N	N	N	N	N	N	L	N	N	10	N	N
528	Q^1	4	N	20,000	N	10	500	10	7,000	N	N	15	5,000	50	N	100	N	2,000	N	N	10	N	5	L	N	1,500	30	N	30	N	100
529	gn	7.5	N	70,000	N	50	500	30	50,000	10	20	10	100,000	1,000	N	2,000	N	30,000	50	N	10	N	30	N	100	5,000	10	N	200	500	1,000
530	Trd	1	N	70,000	N	20	500	7	50,000	30	150	100	50,000	20	N	1,000	10	20,000	10	70	10	N	50	N	300	5,000	100	N	50	N	100
MHI 531	Trb	1	N	30,000	N	10	100	5	2,000	N	10	7	10,000	20	N	300	N	5,000	10	5	50	N	N	N	100	2,000	20	N	10	N	50
532	Trd	1	N	70,000	N	150	150	5	50,000	30	50	70	50,000	N	N	1,500	5	20,000	10	50	10	N	50	N	200	3,000	100	N	30	N	50
533	am	1.5	N	70,000	N	50	200	15	30,000	20	20	50	50,000	100	N	200	N	30,000	10	20	10	N	30	N	200	5,000	70	N	100	N	50
534	gp	85	N	70,000	N	10	700	15	20,000	10	20	30	20,000	500	N	200	N	30,000	10	7	70	N	15	N	200	1,500	20	N	100	N	50
535	am	55	N	70,000	N	150	700	30	30,000	20	20	30	50,000	1,000	N	700	10	20,000	70	7	50	N	15	N	500	3,000	50	N	200	N	700

APPENDIX B. TABLE OF CHEMICAL ANALYSES, SCRANTON (Continued)

Sample number	Geologic code (Pl. 7)	cU_3O_8 (ppm)	Ag (ppm)	Al (ppm)	As (ppm)	B (ppm)	Ba (ppm)	Be (ppm)	Ca (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Fe (ppm)	La (ppm)	Li (ppm)	Mn (ppm)	Mo (ppm)	Na (ppm)	Nb (ppm)	Ni (ppm)	Pb (ppm)	Sb (ppm)	Se (ppm)	Sn (ppm)	Sr (ppm)	Ti (ppm)	V (ppm)	W (ppm)	Y (ppm)	Zn (ppm)	Zr (ppm)
MHI 649	Dck	71	1	57,100	70	145	395	11	815	15	62	18	14,700	12	35	660	10	6,200	7	33	36	31	4	3	100	1,920	300	25	6	230	41
650	Dck	263	1	57,600	100	150	290	12	1,190	13	56	47	15,900	9	30	440	12	8,800	4	25	67	33	3	3	100	1,340	150	79	9	230	32
651	gnb	70	N	70,000	N	200	700	7	2,000	20	N	10	50,000	20	N	1,500	N	15,000	10	50	700	N	20	N	100	3,000	200	N	30	3,000	20
652	al	7	N	70,000	N	100	700	30	5,000	N	N	L	50,000	300	N	100	N	30,000	50	N	20	N	N	N	500	2,000	15	N	100	N	300
653	Dck	710	70	70,000	300	20	700	20	3,000	20	70	6	15,000	150	N	1,500	20	20,000	10	20	1,500	N	20	N	100	7,000	5,000	N	20	N	700
MHI 654	MDsk	410	0.5	70,000	200	100	500	20	500	30	100	70	30,000	100	N	200	N	7,000	20	50	500	N	20	L	100	5,000	700	N	20	N	500
655	MDsk	110	N	60,000	N	50	200	15	500	15	150	70	50,000	50	N	100	N	2,000	10	20	50	N	10	N	100	2,000	300	N	10	N	70
656	Dck	11	1	58,600	100	165	295	11	1,140	11	65	6	14,900	13	30	475	11	800	8	25	26	29	4	3	100	1,940	61	66	5	170	48
657	Dck	678	1	37,300	67	170	1,410	9	5,270	9	53	15	12,400	5	25	705	7	7,400	2	25	350	16	1	2	100	1,010	76	37	14	305	25
658	Dck	790	2	38,800	115	170	2,560	9	12,700	13	200	85	11,700	7	30	1,010	29	7,800	3	27	530	19	2	1	100	890	170	43	77	280	25
MHI 659	Dck	53	1	65,200	125	190	385	14	1,700	17	72	14	18,800	17	45	810	13	7,400	16	34	40	35	5	7	100	2,930	210	54	9	270	71
661	Dck	50	1	84,500	190	185	890	34	1,630	37	110	4	46,400	37	50	895	22	3,600	4	69	91	66	14	22	120	5,310	145	150	17	240	100
662	mp	600	0.5	30,000	500	50	300	20	500	10	10	20	100,000	50	N	2,000	N	2,000	10	L	300	N	N	N	100	1,000	100	N	20	200	70
663	ℙ 1	2	N	50,000	N	N	50	10	1,000	N	10	15	3,000	50	N	20	N	1,500	N	L	L	N	5	N	100	2,000	15	N	10	N	200
664	ℙ 1	3	N	70,000	N	N	700	10	L	N	70	10	10,000	100	N	30	N	7,000	10	L	70	N	15	N	100	3,000	30	N	10	N	70
MHI 665	ℙ 1	4	N	60,000	N	N	500	7	500	10	20	10	10,000	100	N	100	N	2,000	N	L	30	N	5	N	100	2,000	20	N	10	N	300
666	ℙ 1	5	N	40,000	N	N	200	30	500	10	70	30	7,000	50	N	10	N	2,000	N	50	500	N	10	N	100	2,000	30	N	10	L	300
667	ℙ 1	41	N	70,000	N	N	700	15	1,000	10	70	20	7,000	100	N	30	N	10,000	10	20	70	N	15	N	100	10,000	30	N	10	N	300
668	ℙ 1	3	N	70,000	N	N	700	15	1,000	10	50	L	10,000	100	N	20	N	5,000	N	20	30	N	10	N	100	5,000	30	N	10	N	100
669	Dck	9,980	34	51,300	175	170	5,230	21	1,770	23	160	1,130	21,400	12	75	1,320	20	6,200	31	33	360	29	6	8	120	2,180	450	61	645	240	55
MHI 670	MDsk	1	1	10,000	700	50	20	2	L	10	10	30	100,000	20	N	70	N	N	10	30	50	N	N	N	100	200	10	N	N	L	N
671	gd	220	N	70,000	N	20	700	15	20,000	10	10	70	50,000	300	N	200	N	30,000	10	N	100	N	N	N	300	1,000	10	N	10	N	200
672	am	89	N	60,000	N	50	100	30	70,000	30	10	100	70,000	700	N	300	N	15,000	70	N	10	N	N	N	100	2,000	15	N	20	N	500
673	hg	11	N	70,000	N	20	700	70	30,000	15	70	L	70,000	300	N	500	N	20,000	30	5	10	N	30	N	500	5,000	30	N	G200	L	G1,000
674	Dck	2	N	50,000	N	10	300	10	1,500	15	50	L	30,000	100	N	300	N	10,000	10	20	10	N	10	N	100	2,000	20	N	10	N	200
MHI 675	Dck	3	N	70,000	N	50	700	15	1,000	15	100	5	50,000	100	N	100	N	10,000	10	30	30	N	20	10	100	3,000	50	N	20	N	100

Q^1 = Peat
Q^2 = Peat underclay
N = Not found
L = Found at lower detection limits
G = Found at levels above standardization limits

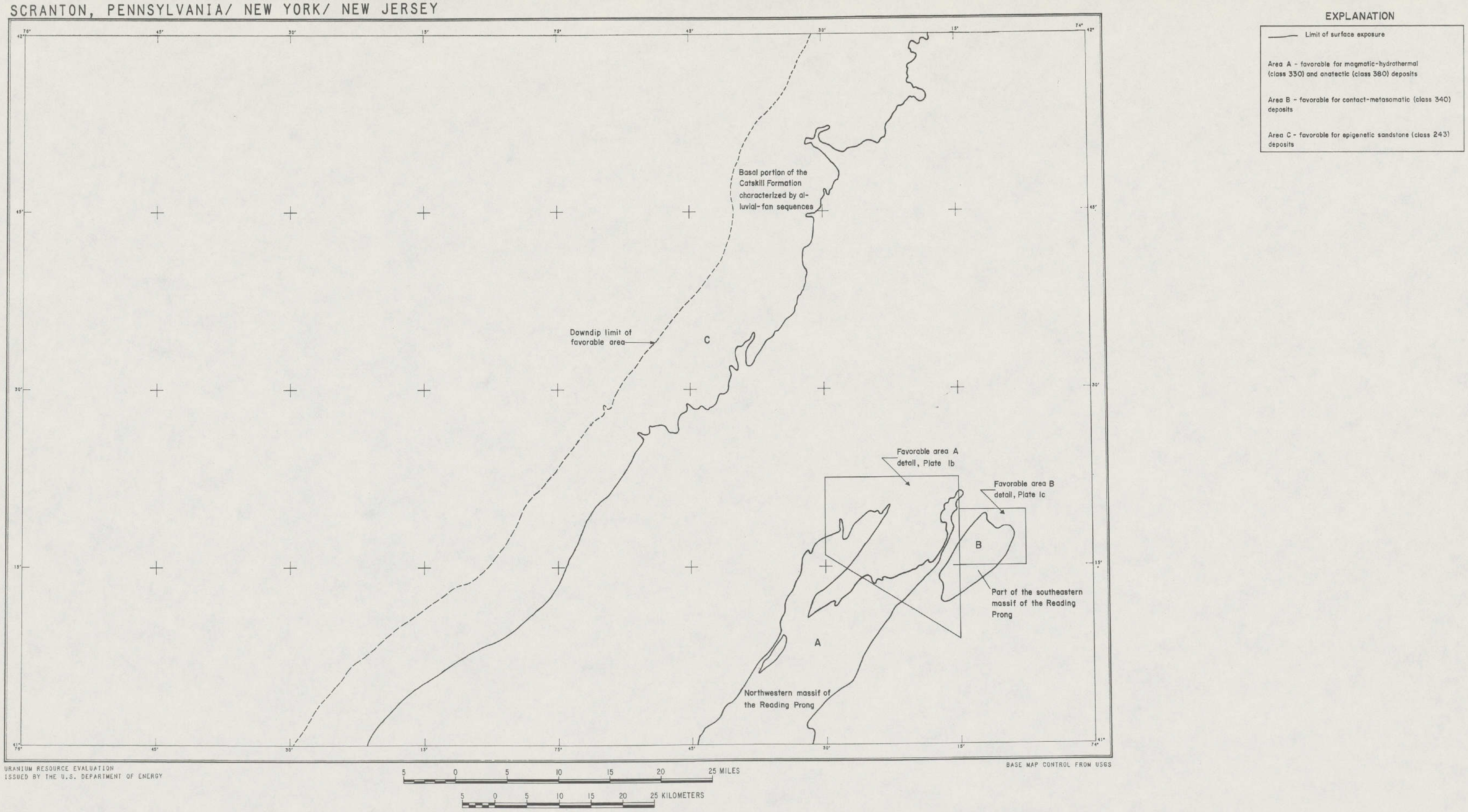
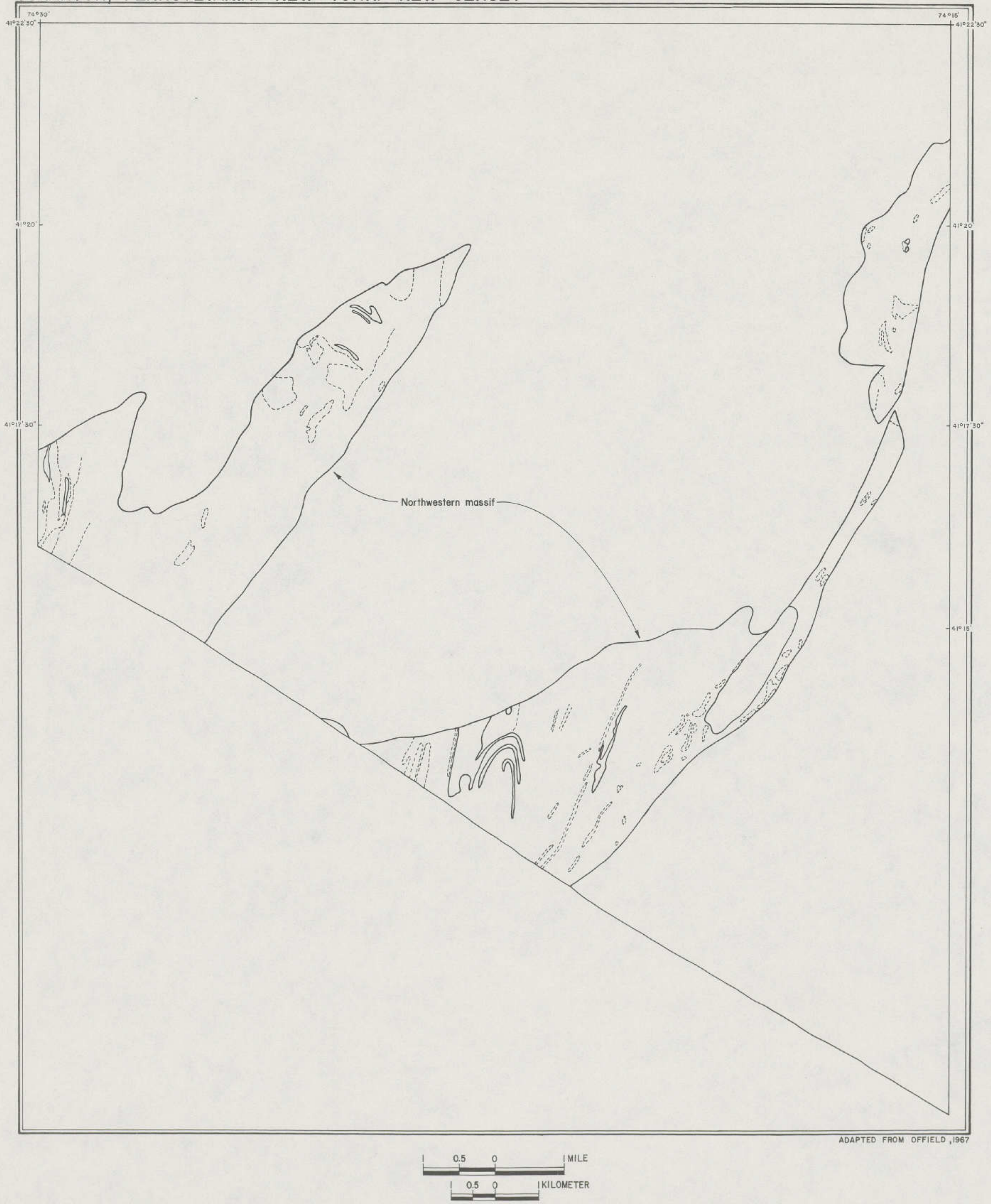


Plate Ia. AREAS FAVORABLE FOR URANIUM DEPOSITS



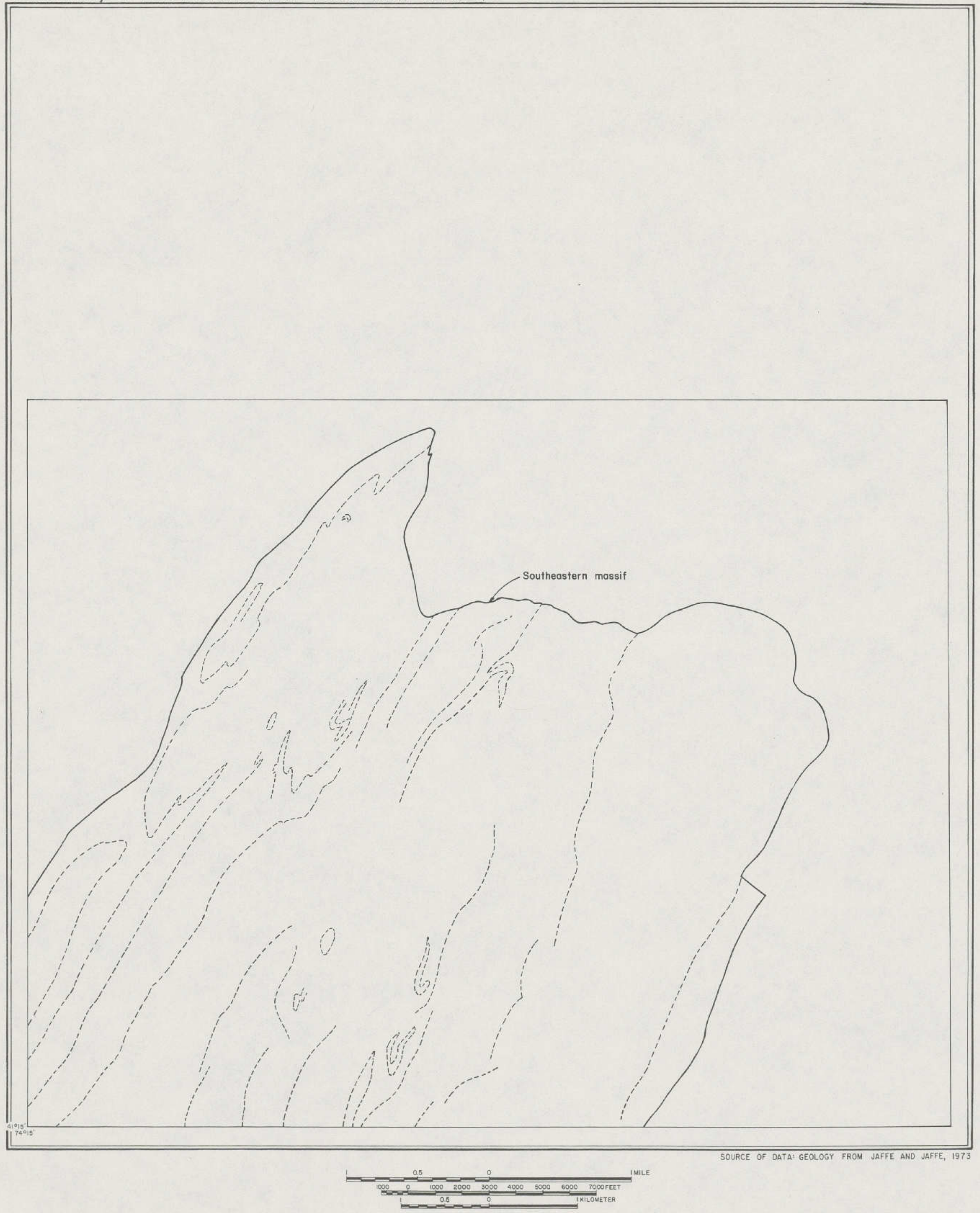
ADAPTED FROM OFFIELD, 1967

EXPLANATION

———	Limit of Precambrian exposure
- - - - - - -	Contact of anatectic igneous rock and metasediments (exclusive of amphibolite) favorable for anatectic (class 380) deposits
———	Area underlain by amphibolite, favorable for magmatic-hydrothermal deposits (Class 330)

Plate Ib. DETAIL OF A PORTION OF FAVORABLE AREA A

SCRANTON, PENNSYLVANIA/ NEW YORK/ NEW JERSEY



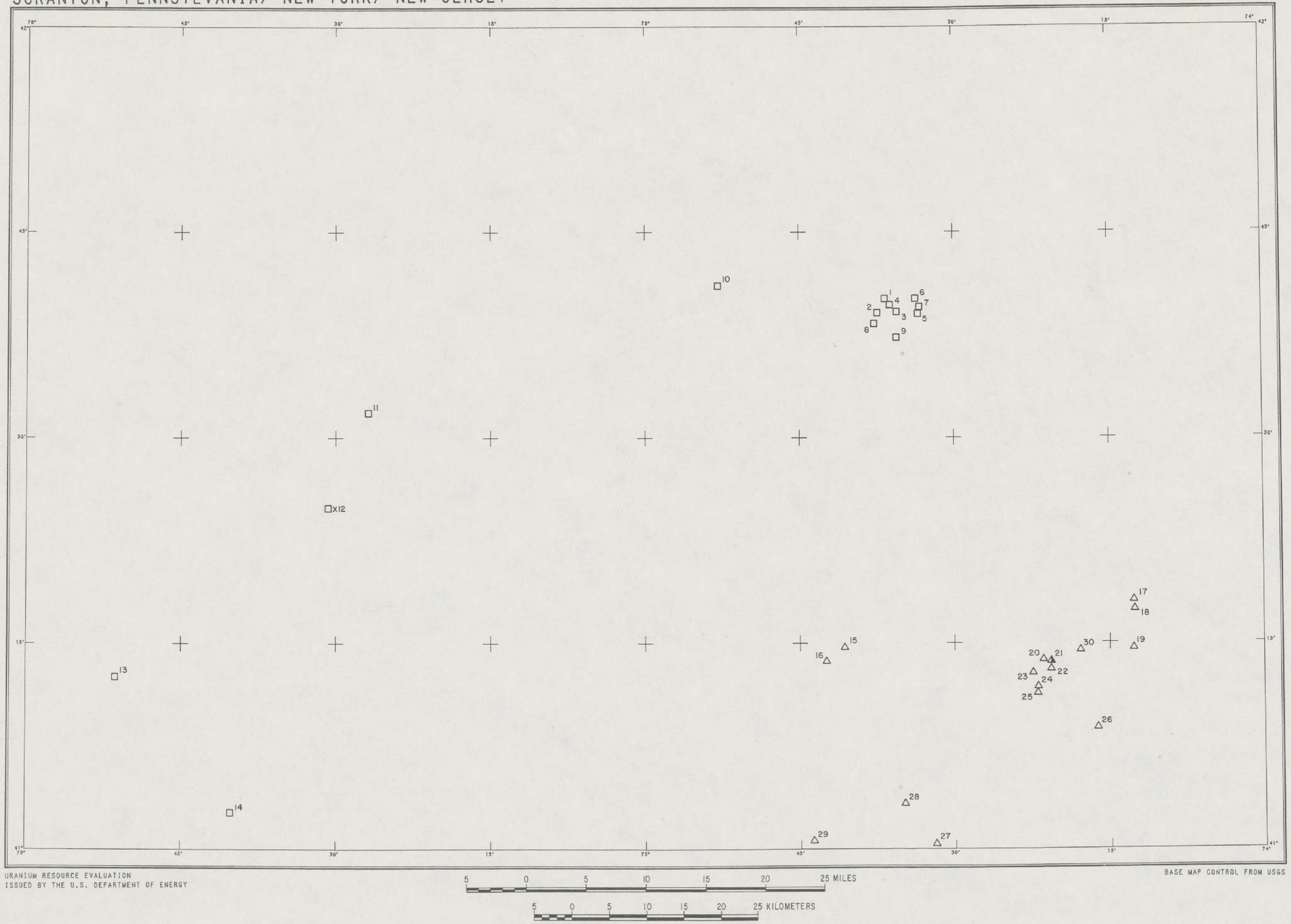
SOURCE OF DATA: GEOLOGY FROM JAFFE AND JAFFE, 1973

EXPLANATION

——	Limit of Precambrian exposure
- - - -	Contact of anatectic igneous rock and metasediments (including amphibolite) which are favorable for contact-metasomatic deposits (Class 340)

Plate Ic. DETAIL OF A PORTION OF FAVORABLE AREA B

SCRANTON, PENNSYLVANIA/ NEW YORK/ NEW JERSEY



URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

Plate 2. URANIUM OCCURRENCES

EXPLANATION

URANIUM OCCURRENCES

	CLASSIFICATION			
	Sedimentary	Plutonic	Volcanic	Other
Minor prospect or mineral occurrence	□	△	⬠	☼
Prospect or mine, production unknown	⬓	▲	⬟	✹
Significant prospect or mine reporting minor production	◪	◭	⬟	✹
Mine having production over 200,000 pounds U_3O_8	■	▲	⬟	✹
Not visited	□Y	△Y	⬠Y	☼Y
Not found	□X	△X	⬠X	☼X
Mining District				

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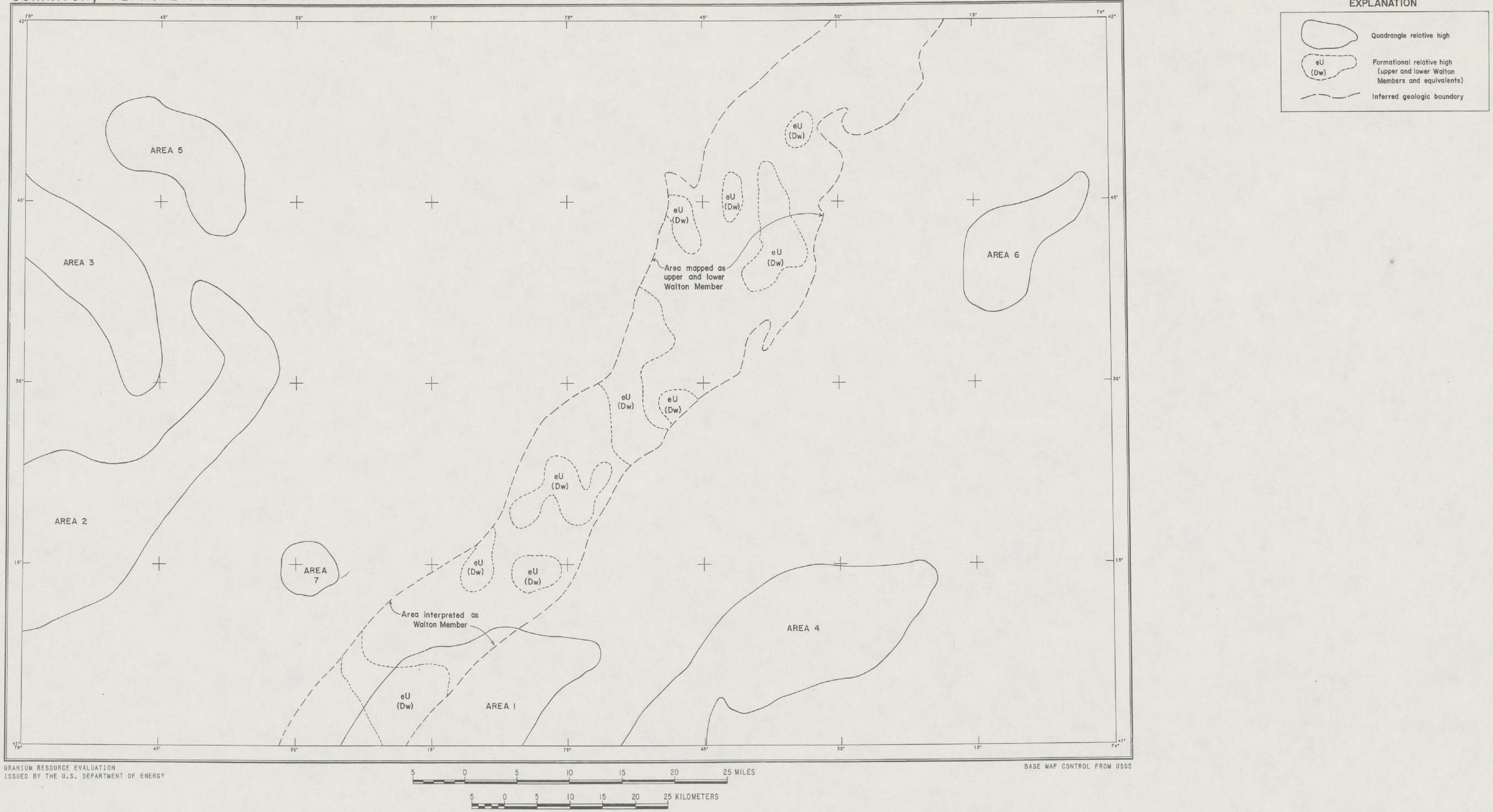
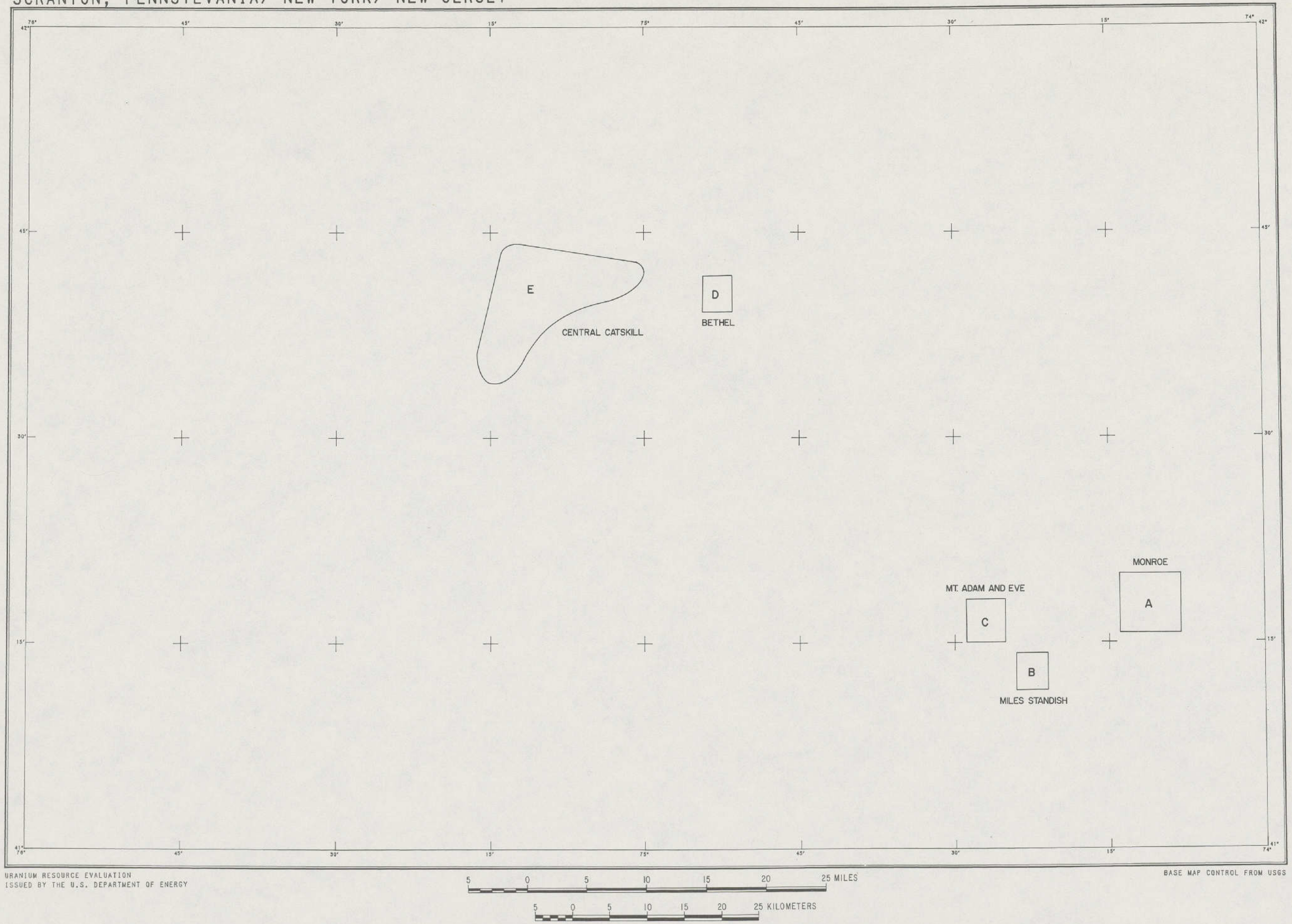


URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

Plate 3. INTERPRETATION OF AERIAL RADIOMETRIC DATA

SCRANTON, PENNSYLVANIA/ NEW YORK/ NEW JERSEY



URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

Plate 4. INTERPRETATION OF DATA FROM HYDROGEOCHEMICAL AND STREAM-SEDIMENT RECONNAISSANCE

EXPLANATION

ANOMALY

A. High uranium in ground water (> 20 ppb) and stream water. High ground-water and stream-sediment uranium residual from multiple regression. Excellent anomaly.

B. High uranium in stream sediments. Low Th/U ratio (< 0.5). Highest stream-sediment uranium residuals from multiple regression. Excellent anomaly.

C. High uranium in ground water (> 20 ppb) and stream water (> 2 ppb). High ground-water uranium residual. Excellent anomaly.

D. High uranium in stream sediments (> 10 ppb). High stream-sediment uranium residuals. Good anomaly.

E. High uranium in ground water (> 10 ppb) probably from resistate minerals. Fair to poor anomaly.

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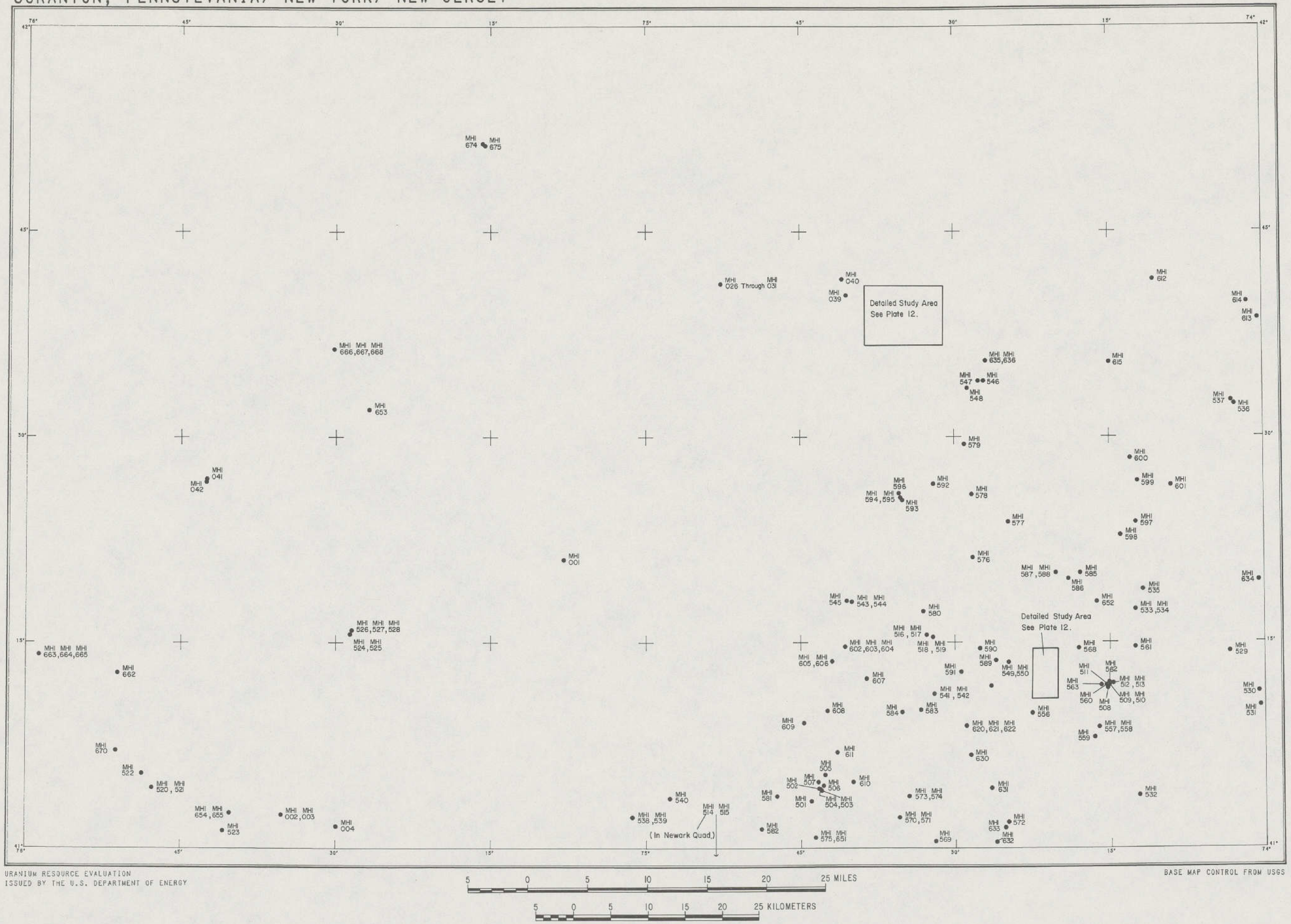
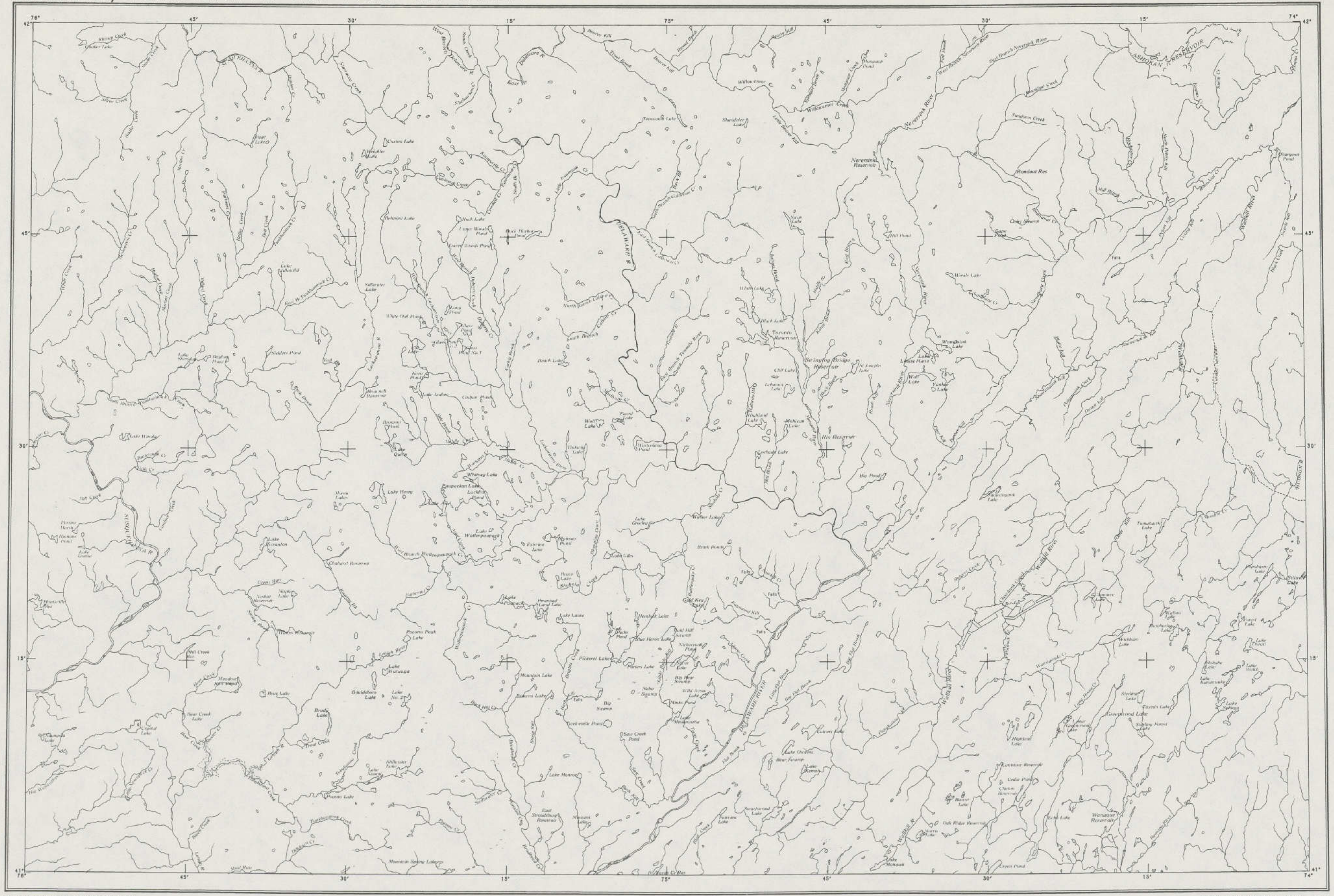


URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

Plate 5. LOCATION OF GEOCHEMICAL SAMPLES



URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

Plate 6. DRAINAGE

SCRANTON, PENNSYLVANIA/ NEW YORK/ NEW JERSEY

See Geologic map legend on Plate 7b.

URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

Plate 7a. GEOLOGIC MAP

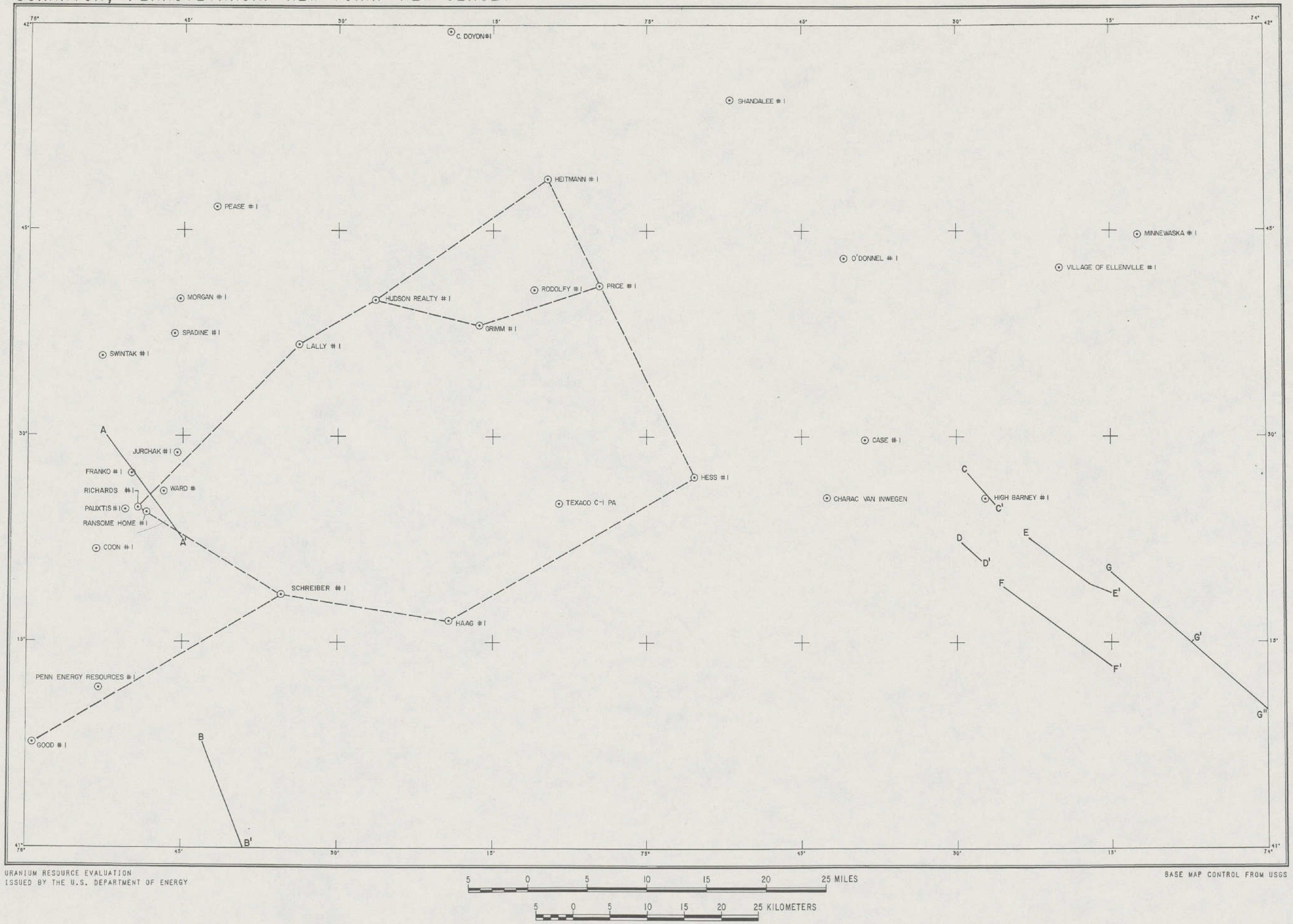
EXPLANATION

CEN.	QUAT.	Q	GLACIAL AND ALLUVIAL DEPOSITS	
MESOZOIC	TRIASSIC	T̄Rd	DIABASE	
		T̄Rp	PALISADE DIABASE	
		T̄Rbs	BASALT FLOWS	
		T̄Rb	BRUNSWICK FORMATION	
PALEOZOIC	PENN.	IPl	LLEWELLYN FORMATION	
		IPp	POTTSVILLE FORMATION	
	MISS.	Mmc	MAUCH CHUNK FORMATION	
		Mp	POCONO FORMATION	
		MDsk	SPECHTY KOPF FORMATION	
	UPPER DEVONIAN	DcK	CATSKILL FORMATION	Ds SUSQUEHANNA GROUP
		Dwh	HONESDALE MEMBER	
		Dws	SLIDE MOUNTAIN FORMATION	
		Dsw	UPPER WALTON MEMBER	
		Dsw	LOWER WALTON MEMBER	
		Dwrg	GARDEAU FORMATION	
		Dgo	ONEONTA FORMATION	
		Dm	MARINE BEDS	
	MIDDLE DEVONIAN	Dhmo	MOSCOW FORMATION	
		Dhpl	PLATTEKILL AND ASHOKAN FORMATIONS	
		Dsc	SKUNNEMUNK CONGLOMERATE	
		Dbp	BELLVALE SANDSTONE AND PEQUANAC SHALE	
		Dkn	KANOUSE SANDSTONE	
PALEOZOIC	MIDDLE DEVONIAN	Dmh	MAHANTANGO FORMATION	Dh/Dho HAMILTON GROUP
		Dmo	MARCELLUS FORMATION	
		Don	ONONDAGA FORMATION	
		Dhm	LOWER HAMILTON GROUP	
	LOWER DEV.	Do	ORISKANY FORMATION	Doh ORISKANY-HELDERBERG UNDIFFERENTIATED
		Dhb	HELDERBERG FORMATION	
		Du	DEVONIAN UNDIFFERENTIATED	
	SILURIAN	Skt	KEYSER AND TONOLOWAY FORMATIONS	
		Sbm	BLOOMSBURG FORMATION	
		Sgp	GREEN POND CONGLOMERATE	
		Sc	CLINTON GROUP	
		Ss	SHAWANGUNK FORMATION	
		Su	SILURIAN UNDIFFERENTIATED	
	ORDOVICIAN	Ojb	JACKSONBURG FORMATION	
		Or	REEDSVILLE FORMATION	
		Ocn	COBURN, SALONA, AND NEALMONT FORMATIONS	
		Om/Omb	MARTINSBURG FORMATION	
		Ohm	HERSHEY AND MYERSTOWN FORMATIONS	
		Ob	BEEKMANTOWN GROUP	
		On	NITTANY FORMATION	
		Ocs	CONESTOGA FORMATION	
		Oqu	QUASSAIC QUARTZITE	
		Obal	BALMVILLE LIMESTONE	
		Omi	MT. MERINO AND INDIAN RIVER FORMATIONS	
		Ou	ORDOVICIAN UNDIFFERENTIATED	
PALEOZOIC		OЄs	CAMBRO-ORDOVICIAN UNDIFFERENTIATED	
	CAMBRIAN	Єs	STISSING FORMATION	
		Єa	ALLENTOWN FORMATION	
		Єh	HARDYSTON FORMATION	
		Єl	LEITHSVILLE FORMATION	
		Єw	WARRIOR FORMATION	
		Єu	CAMBRIAN UNDIFFERENTIATED	
		ns	NEPHELINE SYENITE	POST ORDOVICIAN
		bb	DIATREME	
		p	PHONOLITE	
PRECAMBRIAN		gd	GRANODIORITE	
		hg/gh/hgg	HORNBLENDE GRANITE AND GNEISS	
		ga	ALASKITE	
		gns	PYROXENE SYENITE	
		gpc/gpx	PYROXENE GNEISS	
		gr	GRANITE	
		gnm	MICROCLINE GNEISS	
		ghb	HORNBLENDE-BIOTITE GRANITE	
		hqa	HYPERSTHENE-QUARTZ-ANDESINE GNEISS	
		lg	LEUCOCRATIC GRANITE GNEISS	
		lgn	LOSEE GNEISS	
		am	AMPHIBOLITE	
		amg	AMPHIBOLITE AND GRANODIORITE	
		bg	BIOTITE GRANITE GNEISS	
		bgn	BYRAM GNEISS	
PRECAMBRIAN		bqpc	BIOTITE-QUARTZ GNEISS	
		qo	QUARTZ-OLIGOCLASE GNEISS	
		qob	QUARTZ OLIGOCLASE-BIOTITE GNEISS	
		qs	SILLIMANITE GNEISS	
		qtcs	GARNET-BIOTITE GNEISS	
		rg	RUSTY AND GRAY GNEISS	
		fl	FRANKLIN MARBLE	
		mt	MAGNETITE	
		gp	PEGMATITE	

The stratigraphic terminology is that used by the New York and Pennsylvania State Geological Surveys, which is also the terminology commonly used by workers in the field.

Plate 7b. GEOLOGIC LEGEND

SCRANTON, PENNSYLVANIA/ NEW YORK/ NEW JERSEY



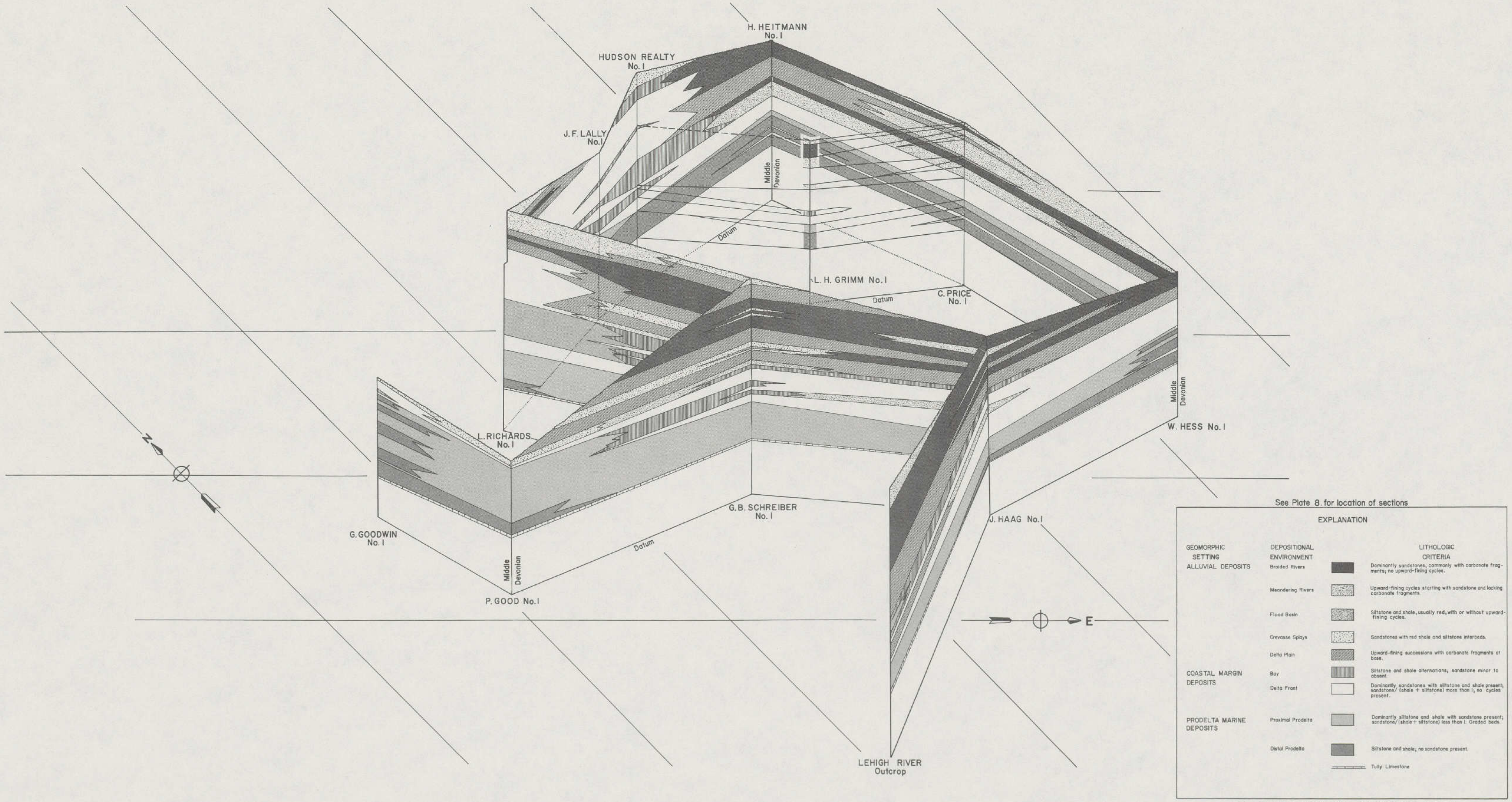
URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

EXPLANATION

⊙	Deep wells (see Appendix D)
— —	Stratigraphic correlation sections (Plate 9)
——	Structural cross sections (Plates 10 and 11)

Plate 8. DEEP WELLS IN THE SCRANTON QUADRANGLE AND LOCATIONS OF CROSS SECTIONS



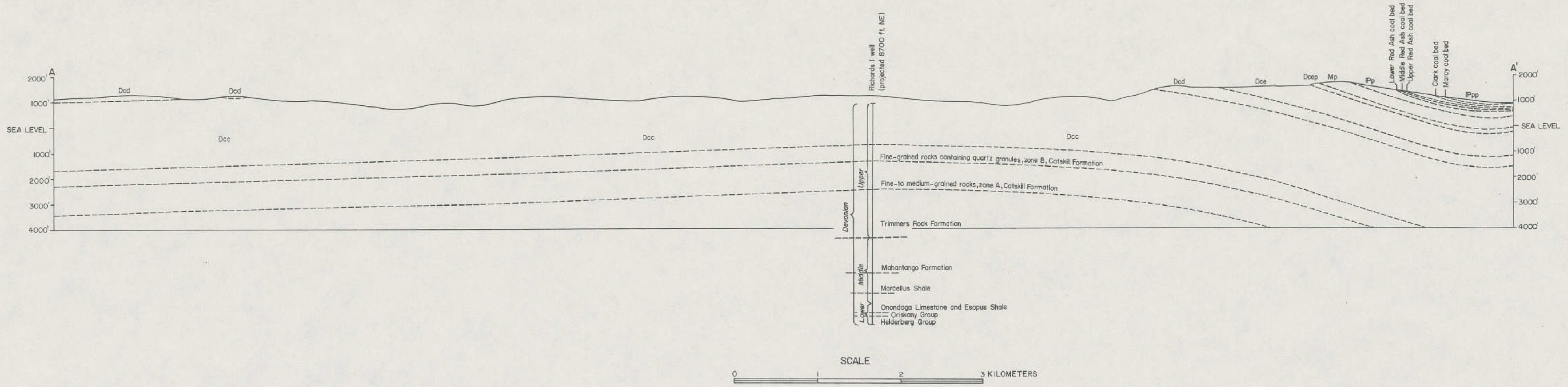
See Plate 8. for location of sections

EXPLANATION

GEOMORPHIC SETTING	DEPOSITIONAL ENVIRONMENT		LITHOLOGIC CRITERIA
ALLUVIAL DEPOSITS	Braided Rivers	■	Dominantly sandstones, commonly with carbonate fragments; no upward-fining cycles.
	Meandering Rivers	░	Upward-fining cycles starting with sandstone and lacking carbonate fragments.
	Flood Basin	▒	Siltstone and shale, usually red, with or without upward-fining cycles.
	Crevasse Splays	░	Sandstones with red shale and siltstone interbeds.
	Delta Plain	▓	Upward-fining successions with carbonate fragments at base.
COASTAL MARGIN DEPOSITS	Bay	▥	Siltstone and shale alternations, sandstone minor to absent.
	Delta Front	□	Dominantly sandstones with siltstone and shale present; sandstone/ (shale + siltstone) more than 1; no cycles present.
PRODELTA MARINE DEPOSITS	Proximal Prodelta	▒	Dominantly siltstone and shale with sandstone present; sandstone/(shale + siltstone) less than 1. Graded beds.
	Distal Prodelta	▓	Siltstone and shale; no sandstone present.
		━	Tully Limestone

FROM: PENNSYLVANIA GEOLOGICAL SURVEY GENERAL GEOLOGY
REPORT 63, 1979 BY J. D. GLAESER

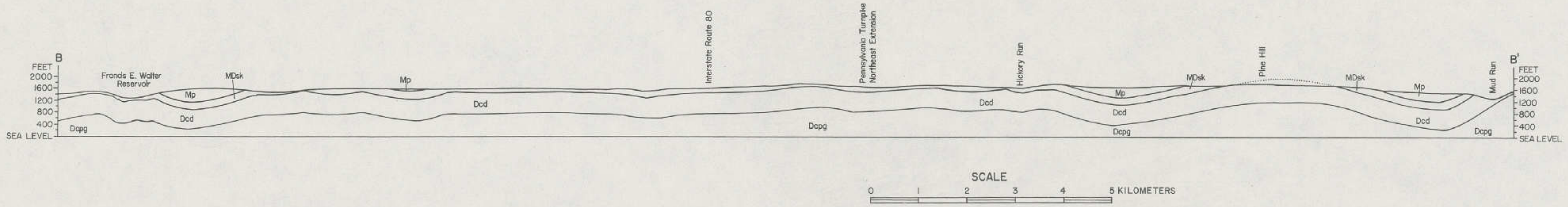
Plate 9. CORRELATION DIAGRAM OF DEEP WELLS IN THE PENNSYLVANIA PORTION OF THE SCRANTON QUADRANGLE



LEGEND (SECTION A-A')

ℙpp	POST-POTTSVILLE ROCKS
ℙp	POTTSVILLE FORMATION
Mp	POCONO FORMATION
Dcep Dce Dcd Dcc	CATSKILL FORMATION

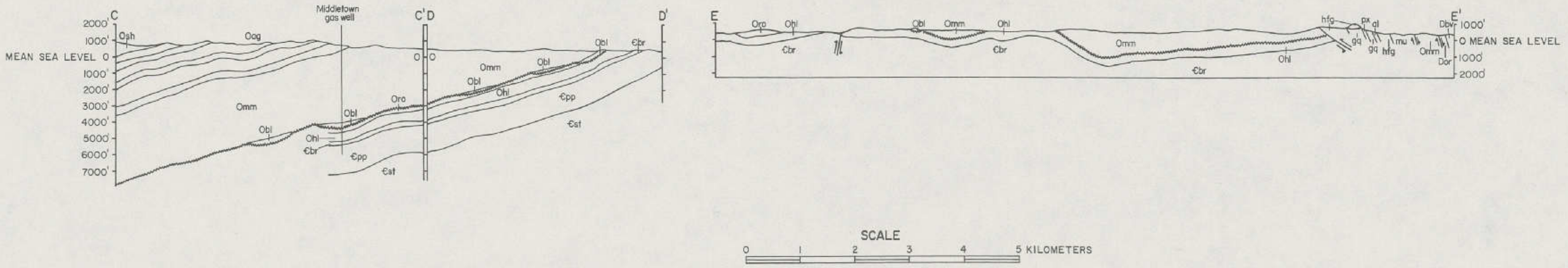
FROM USGS BULLETIN 1213, 1966, BY KEHN AND OTHERS



LEGEND (SECTION B-B')

Mp	POCONO FORMATION	
MDsk	SPECHTY KOPF FORMATION	
Dcd	DUNCANNON MEMBER	CATSKILL FORMATION
Dcpg	POPLAR GAP MEMBER	CATSKILL FORMATION

FROM PENNSYLVANIA GEOLOGIC SURVEY ATLAS 194cd, 1975, BY W. D. SEVON

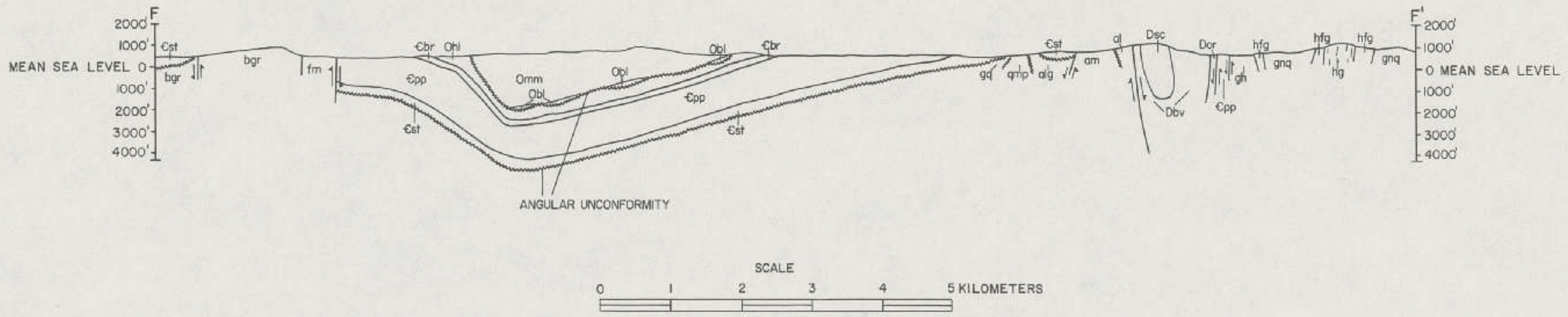


LEGEND (SECTIONS C-E')

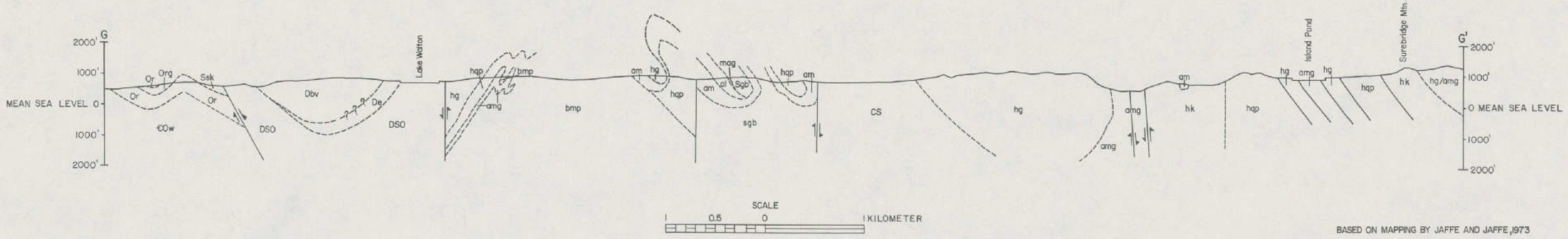
See geologic map legend on Plate II.

FROM NEW YORK STATE MUSEUM AND SCIENCE SERVICE MAP AND CHART SERIES NO. 9, 1967, BY OFFIELD

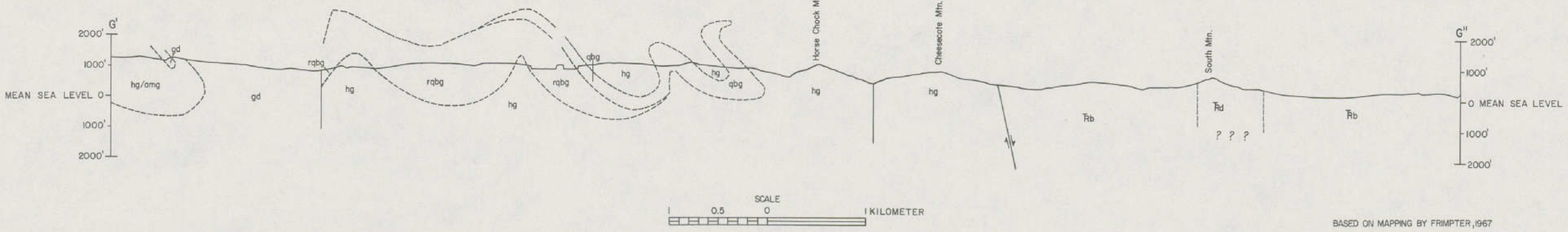
Plate 10. CROSS SECTIONS A THROUGH E



FROM NEW YORK STATE MUSEUM AND SCIENCE SERVICE
MAP AND CHART SERIES NO. 9
1967, BY OFFIELD



BASED ON MAPPING BY JAFFE AND JAFFE, 1973



BASED ON MAPPING BY FRIMPTER, 1967

Plate II. CROSS SECTIONS F AND G

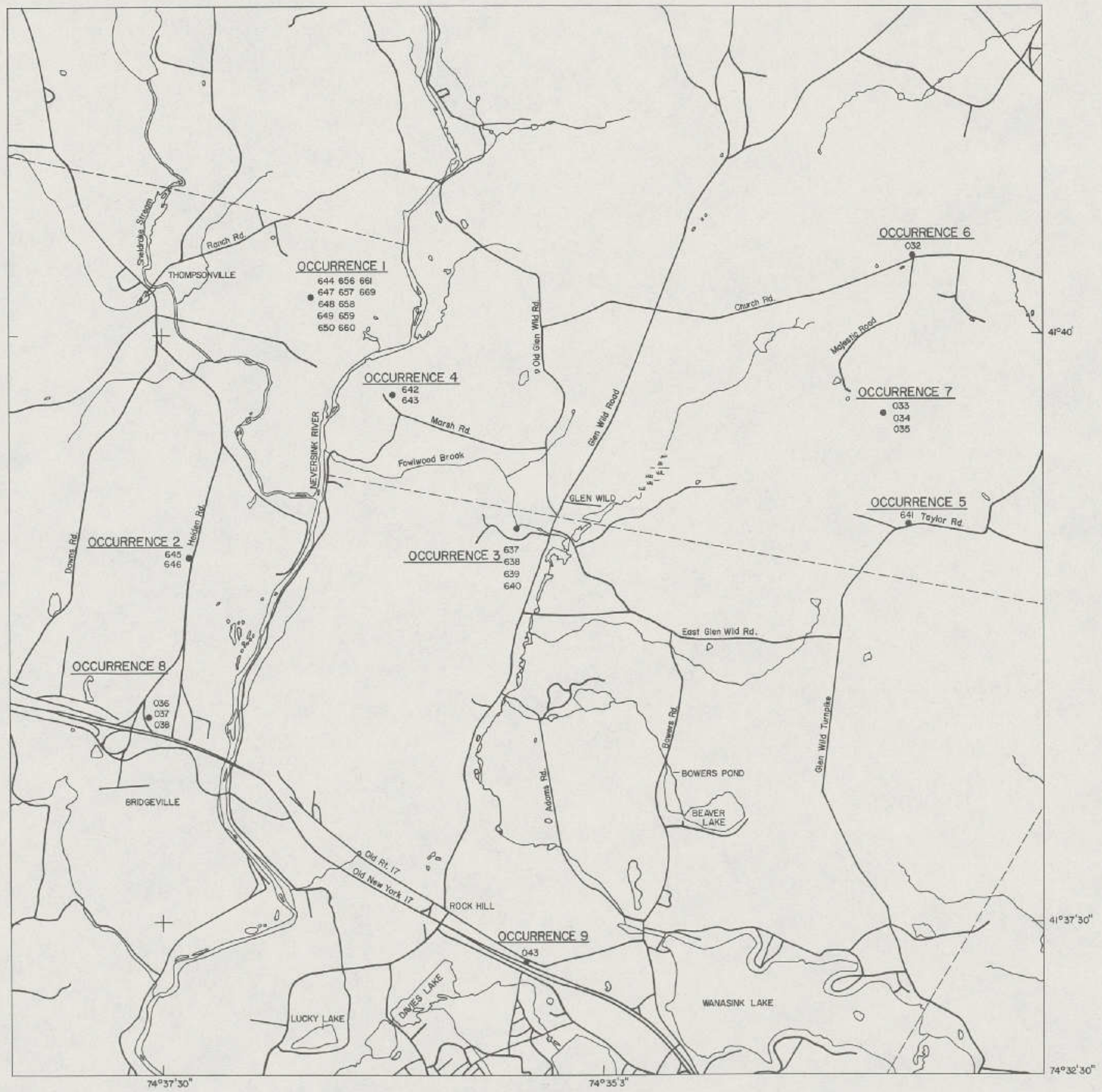
LEGEND (SECTION C-G")

FORMATIONS

T̄Rb	BRUNSWICK FORMATION
T̄Rd	DIABASE DIKE
DSO	CONCEALED DEVONIAN-SILURIAN-ORDOVICIAN
Dsc	SKUNNEMUNK CONGLOMERATE
Dbv	BELLVALE FORMATION
De	ESOPUS SHALE
Dor	ORISKANY SANDSTONE
Ssk	SHAWANGUNK FORMATION
Osh	SNAKE HILL FORMATION
Oag	AUSTIN GLEN FORMATION
Omm	MOUNT MERINO FORMATION
Obl	BALMVILLE FORMATION
Oro	ROCHDALE LIMESTONE
Ohl	HALCYON LAKE FORMATION
Org	RAMEYBURG QUARTZITE
Or	REEDSVILLE SHALE
€br	BRIARCLIFF DOLOMITE
€pp	PINE PLAINS FORMATION
€st	STISSING DOLOMITE
€Ow	WAPPINGER GROUP

ROCK TYPES

al	ALASKITE
alg	ALASKITE GRANITE
am	AMPHIBOLITE
amg	AMPHIBOLITE GNEISS
bgr	BIOTITE GRANITE
bmp	BIOTITE-MESOPERTHITE GNEISS
CS	CALC-SILICATE GNEISS
fm	MARBLE
gd	QUARTZ DIORITE
gh	HORNBLENDE GRANITE
gnq	QUARTZ-PLAGIOCLASE GNEISS
gq	GRAPHITIC QUARTZ-FELDSPAR GNEISS
hfg	HORNBLENDE-FELDSPAR GNEISS
hg	HORNBLENDE GNEISS
hk	BIOTITE-K-FELDSPAR-QUARTZ GNEISS
hqp	HORNBLENDE-QUARTZ-PLAGIOCLASE GNEISS
mag	MAGNETITE-GARNET-ANDESINE GNEISS
mu	METAMORPHIC UNDIFFERENTIATED
px	PYROXENITE
qbg	QUARTZ-BIOTITE GNEISS
qmp	QUARTZ-MICROPERTHITE-PLAGIOCLASE GNEISS
rqbg	RUSTY QUARTZ-BIOTITE-GNEISS
sgb	SILLIMANITE-CORDIERITE-ALMANDINE GNEISS

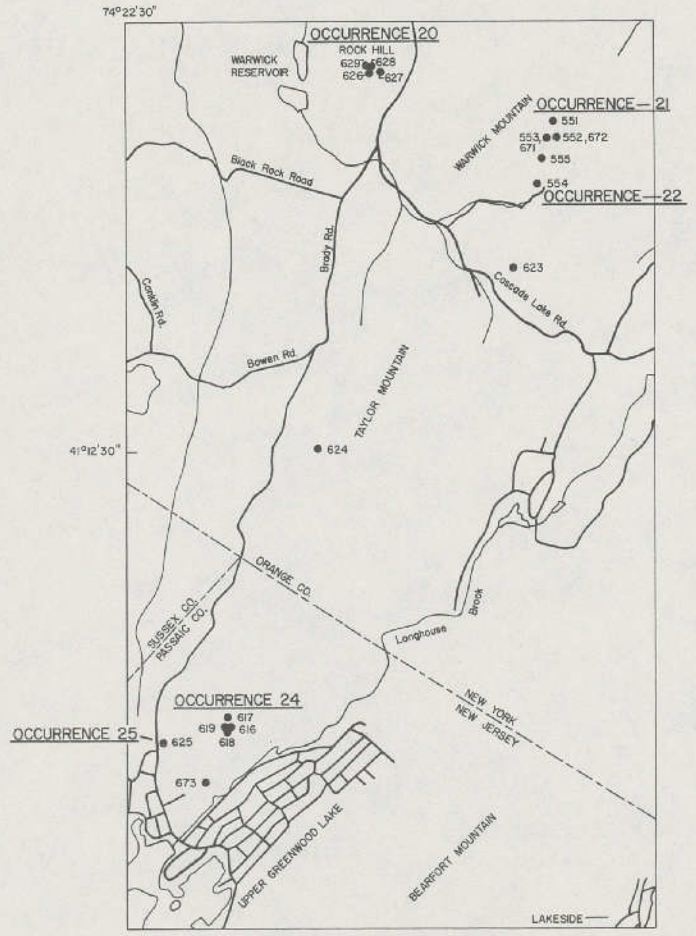


Sample locations in the vicinity of Glen Wild, New York

SCALE

1 ½ 0 1 MILE

1 0.5 0 1 KILOMETER

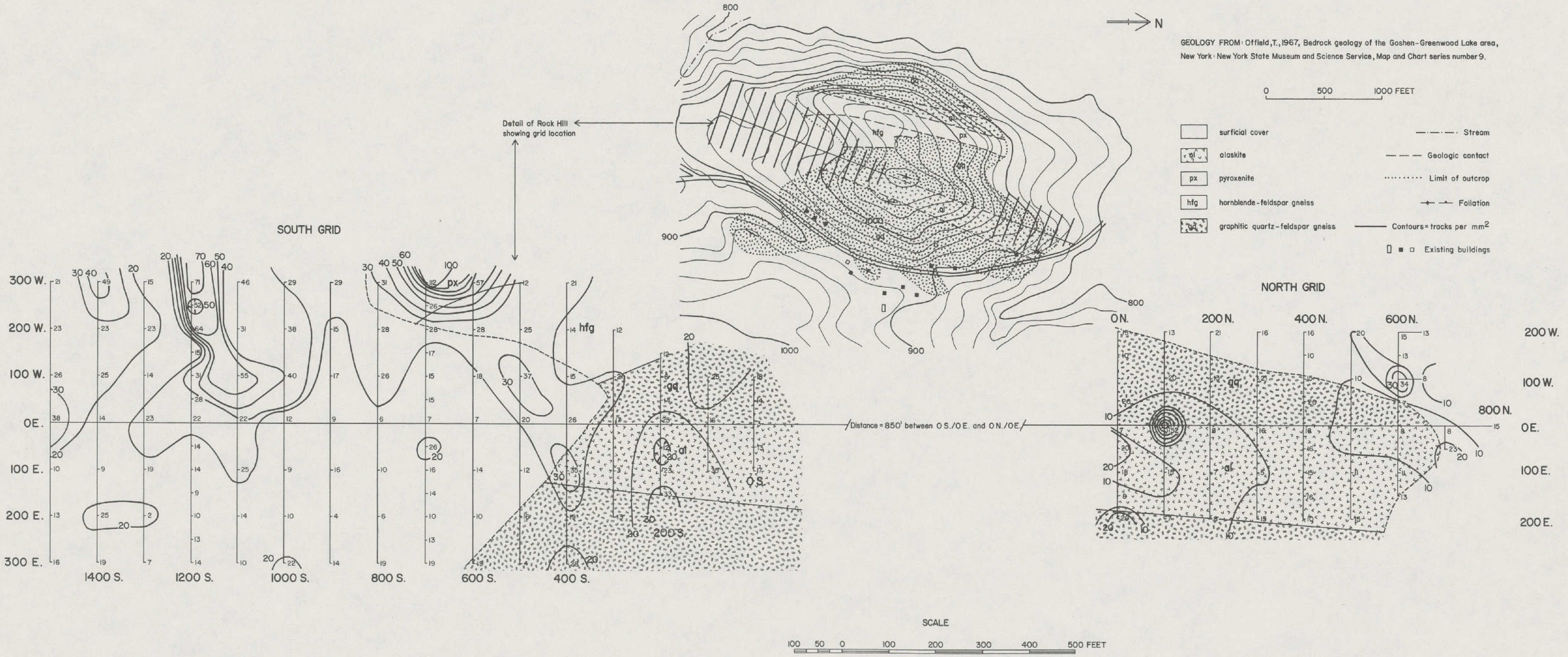


Sample locations near Warwick, New York

EXPLANATION

All sample numbers are preceded by MHI

Plate 12. DETAILED SAMPLE LOCATIONS



GEOLOGY FROM: Offield, T., 1967, Bedrock geology of the Goshen-Greenwood Lake area, New York: New York State Museum and Science Service, Map and Chart series number 9.

Plate 13. RESULTS OF A TRACK ETCH™ RADON SURVEY ON ROCK HILL, WARWICK, NEW YORK

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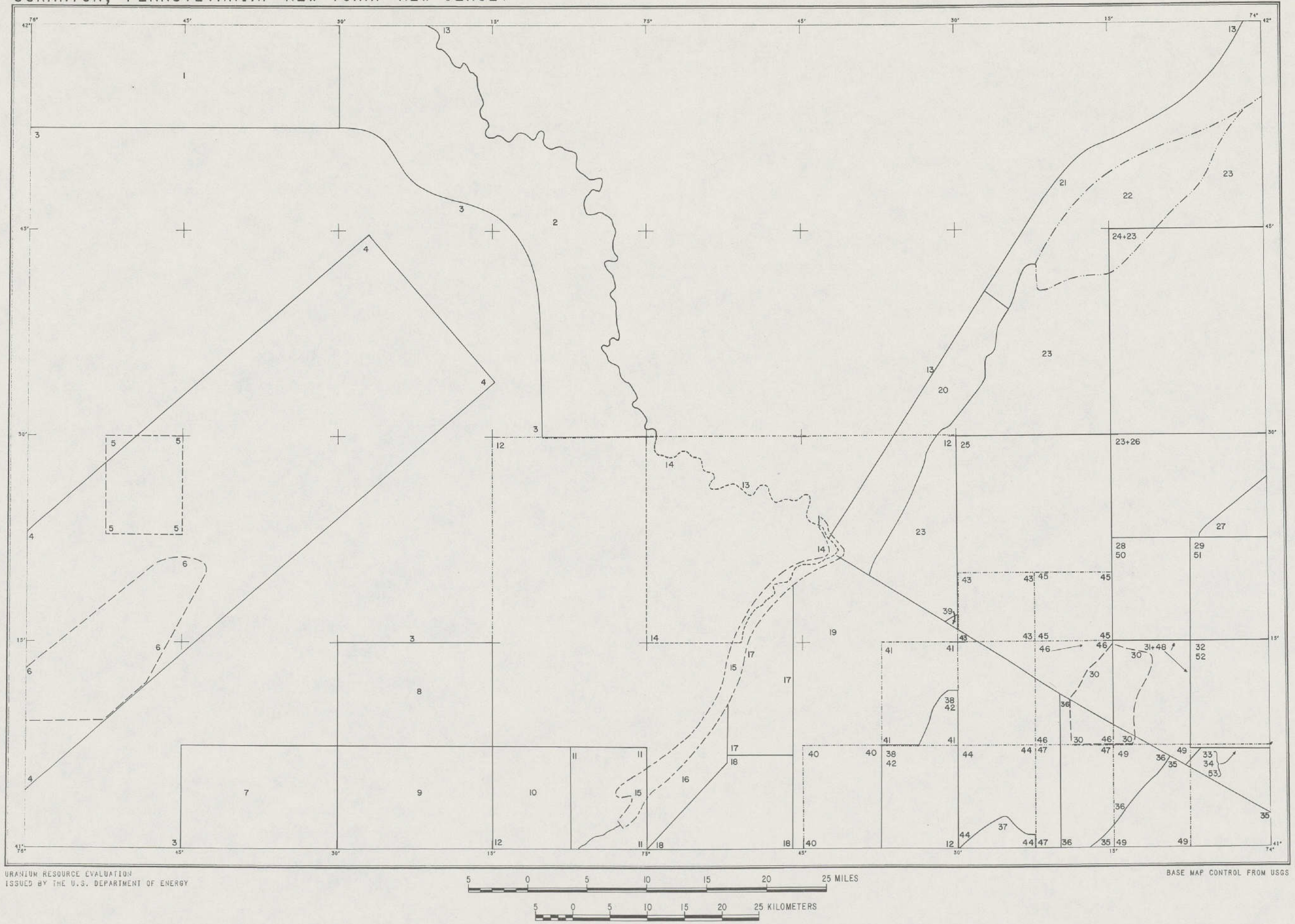

URANIUM RESOURCE EVALUATION
ISSUED BY THE U.S. DEPARTMENT OF ENERGY

BASE MAP CONTROL FROM USGS

Plate 14. GEOLOGIC-MAP INDEX

INDEX

1. Woodrow, 1968, scale 1:62,500.
2. Woodrow and Fletcher, 1968, scale 1:250,000.
3. Pennsylvania Geological Survey, no date, scale 1:24,000.
4. Ash and others, 1954, scale 1:200,000.
5. Kehn, Glick, and Culbertson, 1966, scale 1:24,000.
6. Hollowell, 1971, scale 1:24,000.
7. Sevon, 1975a, scale 1:24,000.
8. Sevon, 1975b, scale 1:24,000.
9. Berg and Sevon, 1977, scale 1:24,000.
10. Bucek, 1971, scale 1:24,000.
11. Alvord and Drake, 1971, scale 1:24,000.
12. Henderson, Andreasen, and Petty, 1966, scale 1:250,000.
13. New York Geological Survey, no date, scale 1:24,000.
14. Fletcher and Woodrow, 1970, scale 1:62,500.
15. Crowl, 1971, scale 1:24,000.
16. Jennings, 1964, scale 1:24,000.
17. Spink, 1966, scale 1:24,000.
18. New Jersey Geological Survey, no date, scale 1:24,000.
19. Smith, 1969; Sims, 1958; Hague and others, 1956; Markewicz and Dalton, 1973; various scales.
20. Rickard, 1960, scales 1:62,500, 1:31,680, and 1:24,000.
21. Chute, 1954-60, scales 1:24,000 and 1:31,680.
22. Rickard, 1960, scales 1:62,500, 1:31,680, and 1:24,000
23. Fisher, 1955-60 and 1967-69, scale 1:24,000.
24. Holzwasser, 1926, scale 1:62,500.
25. Offield, 1967, scale 1:48,000.
26. Kothe, 1960, scale 1:24,000.
27. Helenek, 1971, scale 1:24,000.
28. Jaffe and Jaffe, 1973, scale 1:24,000.
29. Dodd, 1965, scale 1:24,000.
30. Hotz, 1953, scale 1:31,680.
31. Offield, 1960, scale 1:24,000.
32. Frimpter, 1967, scale 1:24,000.
33. Perlmutter, 1959, scale 1:24,000.
34. Savage, 1967, scale 1:24,000.
35. New Jersey Geological Survey, no date, scale 1:24,000.
36. Hotz, 1953, scale 1:24,000.
37. Sims, 1958, scale 1:31,680.
38. Buddington and Baker, 1961, scale 1:24,000.
39. Fisher and others, 1970, scale 1:250,000.
40. Henderson and others, 1957e, scale 1:31,680.
41. Henderson and others, 1957b, scale 1:31,680.
42. Henderson and others, 1957f, scale 1:31,680.
43. Henderson and others, 1957c, scale 1:31,680.
44. Henderson and others, 1957g, scale 1:31,680.
45. Henderson and others, 1957a, scale 1:31,680.
46. Henderson and others, 1957d, scale 1:31,680.
47. Henderson and others, 1957h, scale 1:31,680.
48. Jespersen and Griscom, 1963, scale 1:31,680.
49. Henderson and others, 1962b, scale 1:31,680.
50. Henderson and others, 1962a, scale 1:31,680.
51. Andreasen and others, 1962a, scale 1:31,680.
52. Andreasen and others, 1962b, scale 1:31,680.
53. Philbin and Kirby, 1964, scale 1:31,680.

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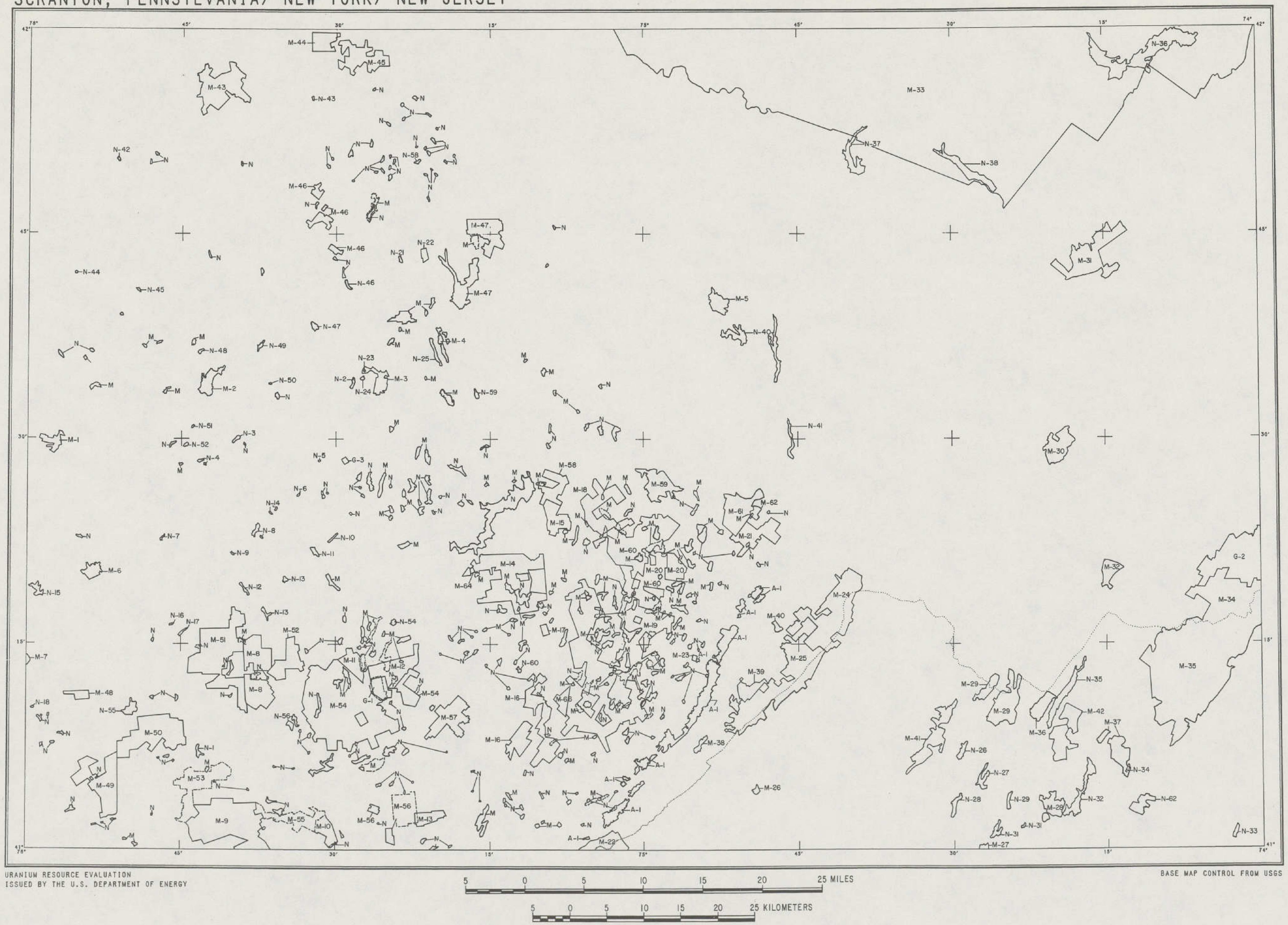

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BASE MAP CONTROL FROM USGS

Plate 15. LAND-STATUS MAP

INDEX

A. Areas Managed by National Park Service

A-1	Delaware Water Gap National Recreation Area

G. Government Installations

G-1	Tobyhanna Military Reservation
G-2	West Point Military Academy
G-3	Land Administered by Federal Aviation Administration

M. State Withdrawals

M-1	Wyoming State Forest
M-2	Proposed State Park
M-3	Fairview State Hospital
M-4	Prompton State Park
M-5	Lake Superior State Park
M-6	Francis Slocum State Park
M-7	State Forest Land
M-8	Lackawana State Forest
M-9	Hickory Run State Park
M-10	Delaware-Lehigh State Experimental Forest
M-11	Goulds Boro State Park
M-12	Tobyhanna State Park
M-13	Big Pocono State Park
M-14	Palmyra State Forest and Promised Land State Park
M-15	State Forest Lands
M-16	Delaware State Forest
M-17	State Forest Lands
M-18	State Forest Lands
M-19	State Forest Lands
M-20	State Forest Lands
M-21	State Forest Lands
M-22	Worthington State Forest and Park
M-23	George W. Childs State Park
M-24	High Point Park State Park
M-25	Stokes State Forest
M-26	Swartswood State Park
M-27	Farney State Park
M-28	Norvin Green State Forest
M-29	Wanaque State Park
M-30	Highland Lakes State Park
M-31	Minnewaska State Park (undeveloped)
M-32	Goosepond Mountain State Park
M-33	Catskill State Park
M-34	Bear Mountain State Park
M-35	Harrinian State Park
M-36	Adam S. Hewitt State Forest
M-37	Ringwood State Park
M-38	Walpack Fish and Wildlife Management Area
M-39	Flatbrook Fish and Wildlife Management Area
M-40	Hainesville Fish and Wildlife Management Area
M-41	Hamburg Mountain Fish and Wildlife Management Area
M-42	Wanaque Fish and Wildlife Management Area
M-43	State Game Lands No. 35
M-44	State Game Lands No. 70
M-45	State Game Lands No. 70
M-46	State Game Lands No. 236
M-47	State Game Lands No. 159
M-48	State Game Lands No. 207
M-49	State Game Lands No. 187
M-50	State Game Lands No. 119
M-51	State Game Lands No. 91
M-52	State Game Lands No. 135
M-53	State Game Lands No. 40
M-54	State Game Lands No. 127
M-55	State Game Lands No. 129
M-56	State Game Lands No. 38
M-57	State Game Lands No. 221
M-58	State Game Lands No. 183
M-59	State Game Lands No. 116
M-60	State Game Lands No. 180
M-61	State Game Lands No. 209
M-62	Buckhorn
M-63	Stillwater
M-64	Pine Lake
M-65	Bruce Lake
M-66	Pennel Run

N. Other Land Categories

N-1	Francis E. Walter Reservoir
N-2	Brownell Reservoir
N-3	Leggets Creek Reservoir
N-4	Summit Lake Reservoir
N-5	Sterry Creek Reservoir
N-6	Marshwood Reservoir
N-7	Falling Springs Reservoir
N-8	Lake Scranton
N-9	Stafford Meadow Reservoir
N-10	Curtis Reservoir
N-11	Scranton Reservoir
N-12	Nesbit Reservoir
N-13	Spring Brook Reservoir
N-14	Roaring Brook Reservoir
N-15	Huntzville Reservoir
N-16	Gardiners Creek Reservoir
N-17	Mill Creek Reservoir
N-18	Hanover Reservoir
N-19	East Stroudsburg Reservoir
N-20	Belmont Lake (Fish Hatchery)
N-21	Hankins Pond (Fish Hatchery)
N-22	Miller Pond (Fish Hatchery)
N-23	Reservoir No. 7
N-24	Carbondale Reservoir
N-25	Prompton Reservoir
N-26	Canistear Reservoir
N-27	Clinton Reservoir
N-28	Oak Ridge Reservoir
N-29	Echo Lake
N-30	Macopin Reservoir
N-31	Charlottesburg Reservoir
N-32	Butler Reservoir
N-33	Wanaque Reservoir
N-34	Woodcliff Lake
N-35	Macmillan Reservoir
N-36	Greenwood Lake
N-37	Ashokan Reservoir
N-38	Neversink Reservoir
N-39	Rondout Reservoir
N-40	Toronto Reservoir
N-41	Swinging Bridge Reservoir
N-42	Rio Reservoir
N-43	Jones Lake
N-44	Canawacta Dam
N-45	Thomas Dam
N-46	Lakeside Pond
N-47	Stillwater Dam
N-48	Crystal Lake
N-49	Baylors Lake
N-50	Sickler Pond
N-51	Coleman Dam
N-52	Glenburn Dam
N-53	Manness Dam
N-54	La Touche Creek
N-55	Pocono Peak Lake
N-56	Crystal Lake
N-57	Arrowhead Dam
N-58	Summit Lake
N-59	Lake Underwood
N-60	Caojaw Pond
N-61	Lake Lenade
N-62	Campgaw Mountain County Reservoir

Note: Unnamed lands set aside for designated use are shown as M or N with no numbers.

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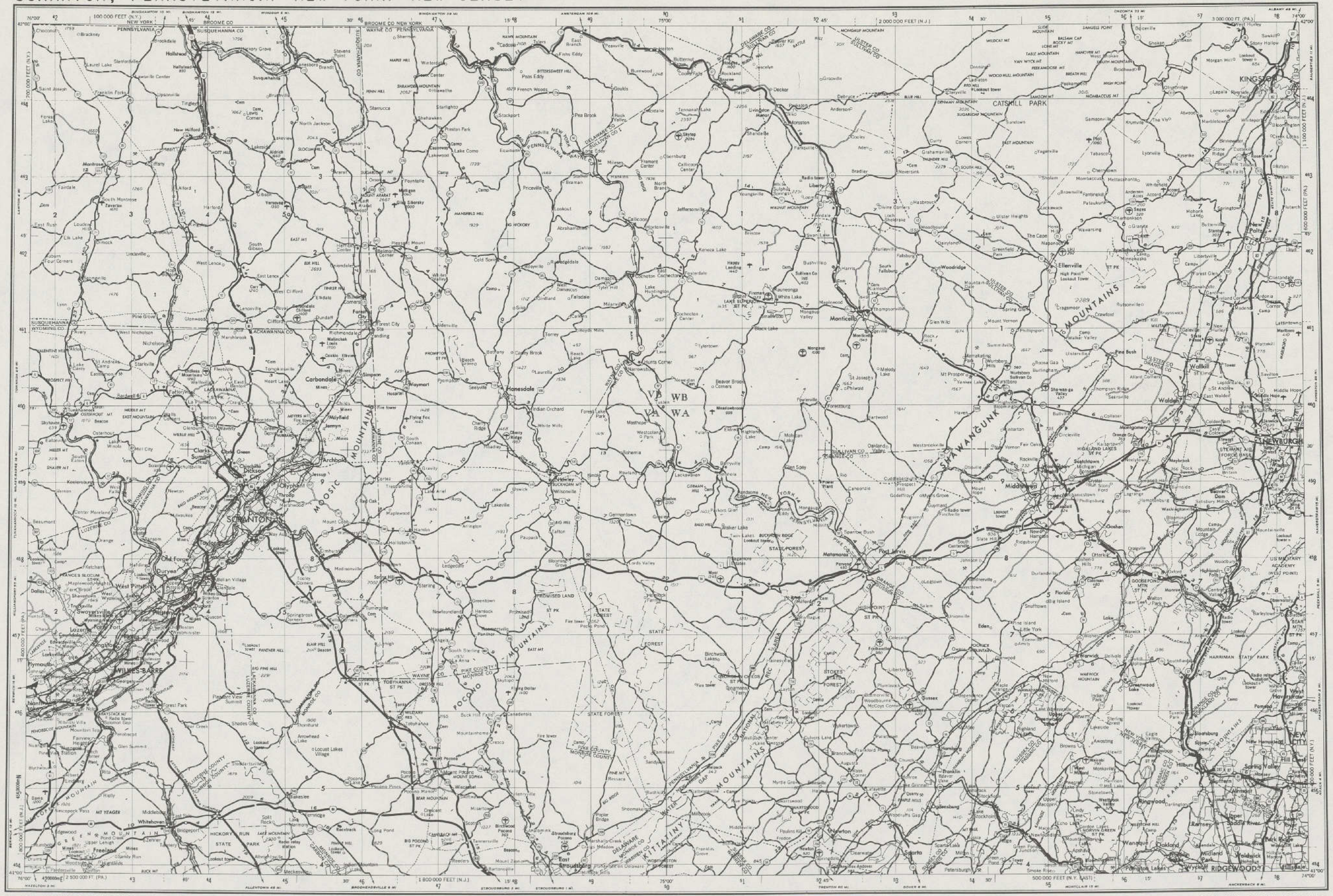

URANIUM RESOURCE EVALUATION
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BASE MAP CONTROL FROM USGS

5 0 5 10 15 20 25 MILES

5 0 5 10 15 20 25 KILOMETERS

Plate 16. CULTURE