SCANNING ELECTRON MICROGRAPHS OF SELECTED SAMPLES FROM PALEOZOIC THROUGH TERTIARY SANDSTONES, NORTH SLOPE, ALASKA.

ARCO KAVIK UNIT #3
ARCO W. MIKKELSEN STATE #2
EXXON ALASKA STATE A #1
EXXON CANNING RIVER UNIT BLK. A #1
EXXON PT. THOMPSON UNIT #2
EXXON DUCK ISLAND UNIT #1
EXXON POINT THOMSON UNIT #1
FOREST KEMIK UNIT #1
MOBIL BELI UNIT #1
MOBIL MIKKELSEN BAY STATE 13-9-19
MOBIL WEST STAINES STATE 18-9-23
SOHIO CHALLENGE ISLAND #1

GMC Data Report 53C

SCANNING ELECTRON MICROGRAPHS OF SELECTED SAMPLES FROM PALEOZOIC THROUGH TERTIARY SANDSTONES, NORTH SLOPE, ALASKA

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ALASKA RESEARCH ASSOCIATES
MARCH, 1984

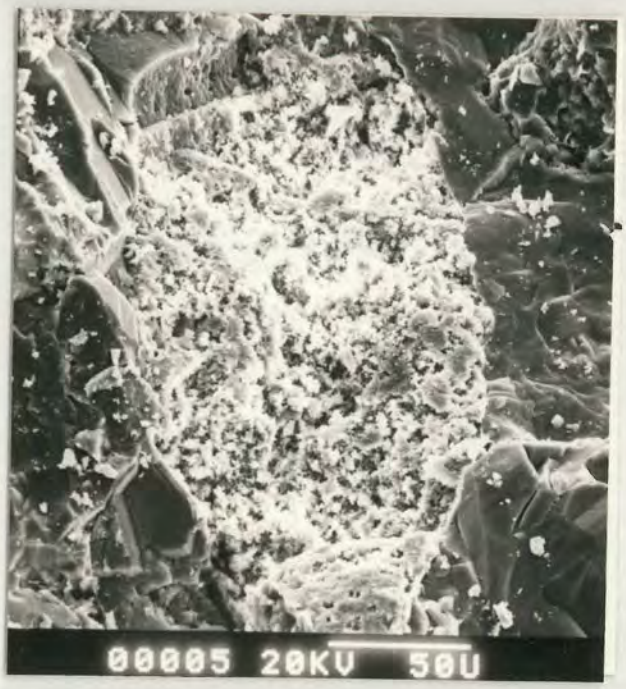
This series of scanning electron micrographs were taken during an evaluation of sandstone reservoir quality conducted by Alaska Research Associates in the latter part of 1983 and early part of 1984. Samples for analysis were selected by Dr. M. D. Wilson. All of the analyses were performed by Dr. Wilson. The objectives of the analysis were the documentation of the pore network properties and/or evaluation of the types, abundances and sequence of development of pore-filling agents.

All of the SEM analyses were conducted using a Hitachi F450 scanning electron microscope at AGAT Consultants, Ltd. in Calgary, Alberta. All samples consisted of small core chips mounted on aluminum stubs and coated with a thin film of gold. Micrographs were taken with a 35mm camera back attached to a port on the SEM console. Magnifications are indicated by a scale bar and value in micrometers at the lower right on each micrograph.

Wells depths and stratigraphic unit designations for each sample used in the study are listed below.

Well Name	Depth	Stratigraphic Unit
ARCO Kavik Unit #3	5430'	Ivishak Ss.
ARCO W. Mikkelsen #2	11250'	Thomson Sand
EXXON Alaska State #A-1	10737'	Colville Sh.
EXXON Canning River #A-1	4882-83'	Ivishak Ss.
EXXON Duck Island #1	11874'	Kekiktuk Cgl.
	11899'	Kekiktuk Cgl.
EXXON Pt. Thomson #1	12160'	Colville Sh.
EXXON Pt. Thomson Unit #2	10204'	Colville Sh.
	10620'	Colville Sh.
	11736'	Colville Sh.
	11774'	Colville Sh.
	13124'	Thomson Sand
FOREST Kemik #1	4610-20'	Kemik Ss.
MOBIL Beli #1	11836'	Ivishak Ss.
MOBIL Mikkelsen Bay St. #13-9-19	10618-19'	Colville Sh.
	11697-98'	Thomson Sand
MOBIL W. Staines #18-9-23	7754-55'	Sagavanirktok Fm.
	12559-60'	Colville Shale
SOHIO Challenge Island #1	13444'	Thomson Sand
	13449'	Thomson Sand


00004 20KV 50U


00005 20KV 50U


00007 20KV 50U


00008 20KV 50U

UPPER LEFT

ARCO Kavik Unit #3, 5430', Ivishak Sandstone, 300X

Only small intergranular pores remain following extensive quartz overgrowth development. Overgrowths on chert grains are absent or very small.

UPPER RIGHT

ARCO Kavik Unit #3, 5430', Ivishak Sandstone, 500X

Intragranular micropores are common in a partially dissolved chert grain. Surrounding intergranular pores are plugged by quartz overgrowths.

LOWER LEFT

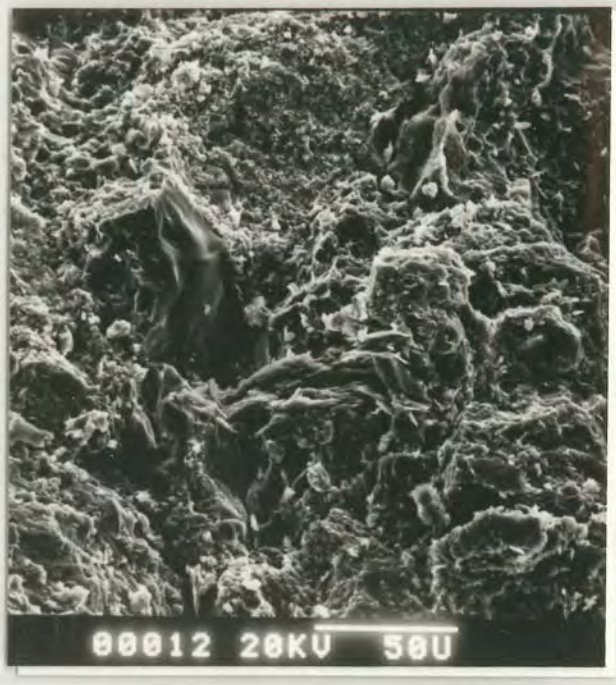
ARCO W. Mikkelsen #2, 11250', Colville Shale, 400X

Extensive infill by detrital clays enhances pressure solution suturing. Note lack of large intergranular pores.

LOWER RIGHT

ARCO W. Mikkelsen #2, 11250', Colville Shale, 1000X

Broken quartz grain (center) exhibits irregular outline due to extensive pressure solution suturing promoted by detrital clays at grain contacts.


00012 20KV 50U


00013 20KV 50U


00014 20KV 50U


00015 20KV 5U

UPPER LEFT

EXXON Alaska State #A-1, 10737', Colville Shale 500X

Extensive ductile deformation and quartz overgrowths have destroyed the bulk of the intergranular porosity.

UPPER RIGHT

EXXON Alaska State #A-1, 10737', Colville Shale 500X

Ductile deformation is the major mechanism of porosity loss in this portion of the sample. Note that micaceous grains have been molded around adjacent rigid grains.

LOWER LEFT

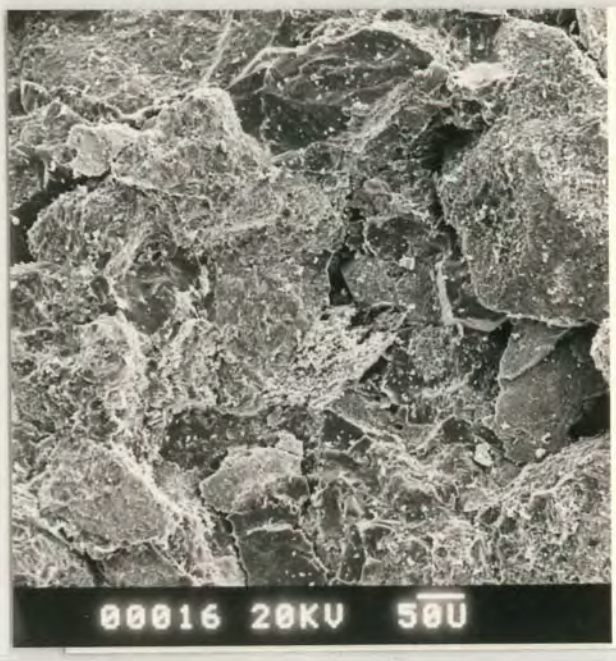
EXXON Canning River #A-1, 4882-83', Ivishak Ss., 700X

Fans of chlorite are distributed throughout a partially dissolved rhomb of siderite. Quartz overgrowths project into adjacent intergranular pores but large pores still remain.

LOWER RIGHT

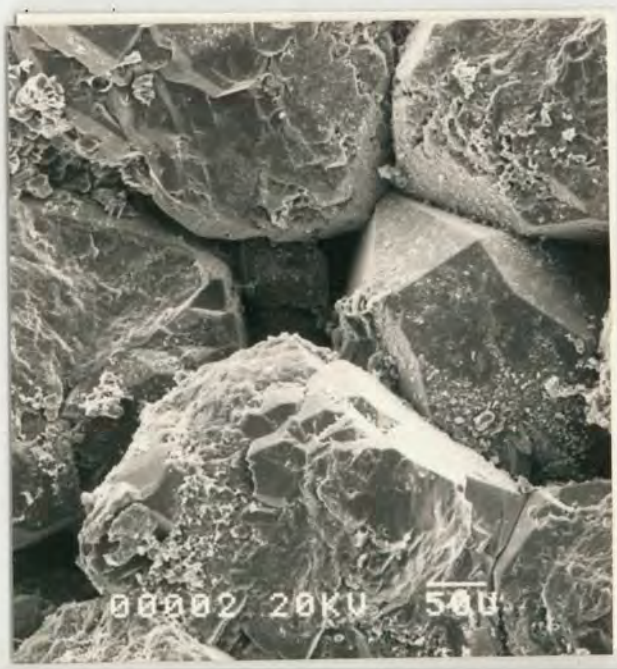
EXXON Canning River #A-1, 4882-83', Ivishak Ss., 6000X

Close-up of siderite rhomb shown in previous micrograph showing fans of fine-silt sized authigenic chlorite.


00016 20KV 50U


00000 20KV 50U


5U


00002 20KV 50U

UPPER LEFT

EXXON Canning River #A-1, 4882-83' Ivishak Ss., 150X

Tightly interlocking quartz overgrowths have eliminated most of the intergranular porosity.

UPPER RIGHT

EXXON Duck Island #1, 11874', Kekiktuk Cgl., 100X

Good visible intergranular porosity is present in a sample cemented by quartz overgrowths. Clusters of authigenic kaolinite books occur in a few pores.

LOWER LEFT

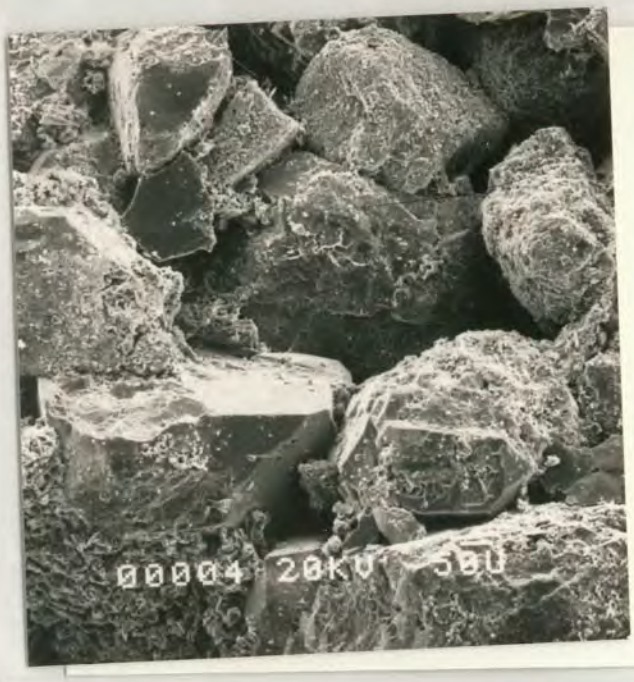
EXXON Duck Island #1, 11874', Kekiktuk Cgl., 2000X

Close-up showing the well-developed pseudohexagonal outlines of kaolinite books plugging the center of an intergranular pore.

LOWER RIGHT

EXXON Duck Island #1, 11874', Kekiktuk Cgl., 200X

Limited quartz overgrowth cementation has allowed preservation of large intergranular pores.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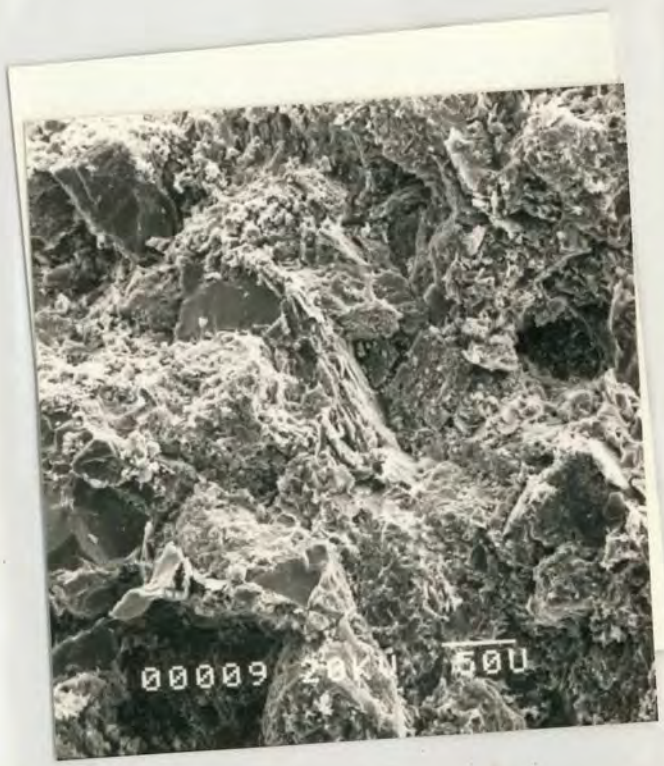
00006 20KV


20KV


00009 20KV 50U

UPPER LEFT

EXXON Duck Island #1, 11899', Kekiktuk Cgl., 100X

Large intergranular pores are present in a sandstone cemented by moderate-sized quartz overgrowths. Kaolinite books plug some pores along the left edge of the micrograph.

UPPER RIGHT

EXXON Duck Island #1, 11899', Kekiktuk Cgl., 400X

Partially dissolved chert grains (center and center right) are bordered by quartz grains with large overgrowths.

LOWER LEFT

EXXON Pt. Thomson #1, 12160' Colville Shale, 1400X

A mica has been ductilely deformed around a rigid grain (right) and has been partially altered to authigenic kaolinite books (center).

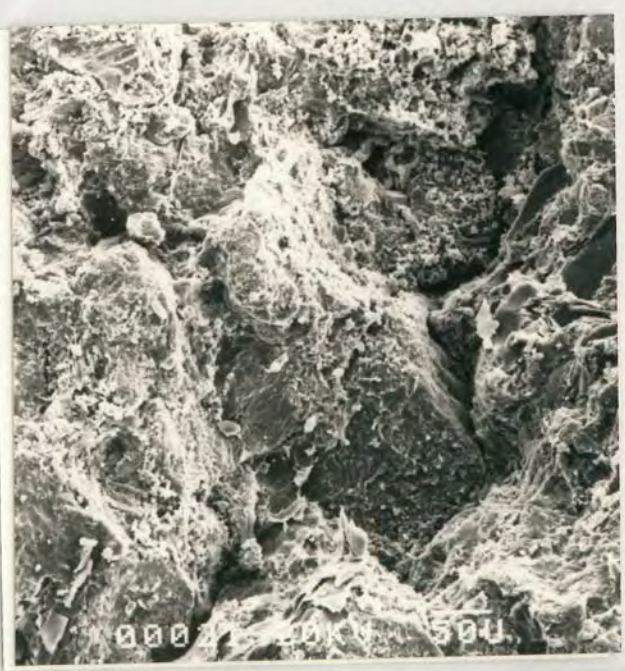
LOWER RIGHT

EXXON Pt. Thomson #1, 12160', Colville Shale, 250X

Only very small amounts of visible porosity are present in a sandstone in which ductile deformation of micas and micaceous schist fragments is extensive.


00019 20KV 5U


5U



UPPER LEFT

EXXON Pt. Thomson #2, 10204', Colville Shale, 900X

Only modest visible intergranular porosity is present in a sandstone cemented extensively by quartz overgrowths (top) and ductile deformation (center).

UPPER RIGHT

EXXON Pt. Thomson #2, 10204', Colville Shale, 1500X

A cluster of authigenic kaolinite books occurs above well-developed quartz overgrowths.

LOWER LEFT

EXXON Pt. Thomson #2, 10204', Colville Shale, 1200X

A partially dissolved argillaceous chert grain occurs in the center of the micrograph and a cluster of authigenic kaolinite at the top. Such intragranular porosity contributes only slightly to the total porosity.

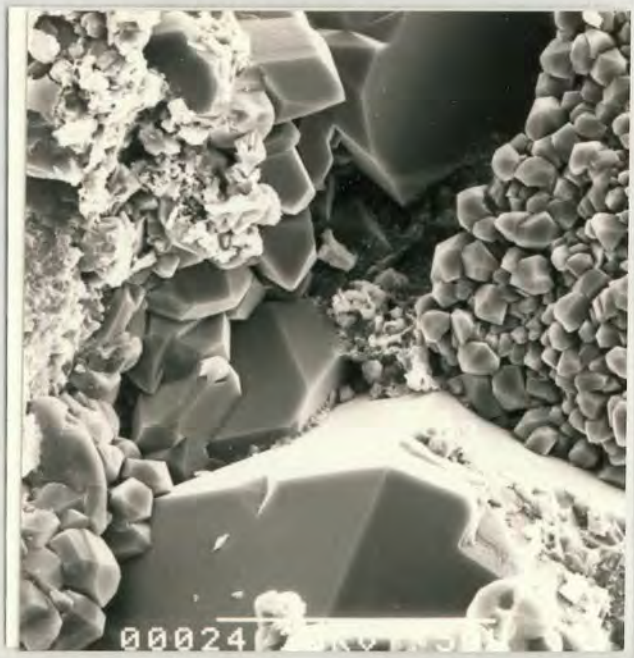
LOWER RIGHT

EXXON Pt. Thomson #2, 10620', Colville Shale, 200X

Relatively low intergranular porosity is present. The major mechanism of porosity loss is ductile deformation along with minor quartz overgrowths.


00022 20KV 5U


20KV 5U


00024


00001 20KV 500

UPPER LEFT

EXXON Pt. Thomson #2, 10620', Colville Shale, 1800X

Intergranular porosity has been destroyed by quartz overgrowths on which clusters of authigenic kaolinite books occur.

UPPER RIGHT

EXXON Pt. Thomson #2, 11736', Colville Shale, 1000X

A siderite rhomb (center) and authigenic kaolinite (lower right) plug the center of a pore primarily filled by quartz overgrowths (upper right).

LOWER LEFT

EXXON Pt. Thomson #2, 11736', Colville Shale 970X

Large quartz overgrowths occur on coarsely crystalline quartz while small overgrowths of diverse orientation occur on chert grains.

LOWER RIGHT

EXXON Pt. Thomson #2, 11774', Colville Shale, 100X

Large intergranular pores are present in a relatively coarse sandstone. Clusters of authigenic kaolinite books plug several of these pores.


00002 20KV 50U


00003 20KV 5U


00004 20KV 5U


00005 20KV 50U

UPPER LEFT

EXXON Pt. Thomson #2, 11774', Colville Shale, 500X

A well-formed quartz overgrowth plugs an intergranular pore. Small overgrowths of diverse orientation occur on the chert grain at the right. Authigenic kaolinite books are present at the upper left.

UPPER RIGHT

EXXON Pt. Thomson #2, 11774', Colville Shale, 3300X

Small quartz overgrowths with diverse orientations are distributed on the surface of the chert grain shown in the previous micrograph.

LOWER LEFT

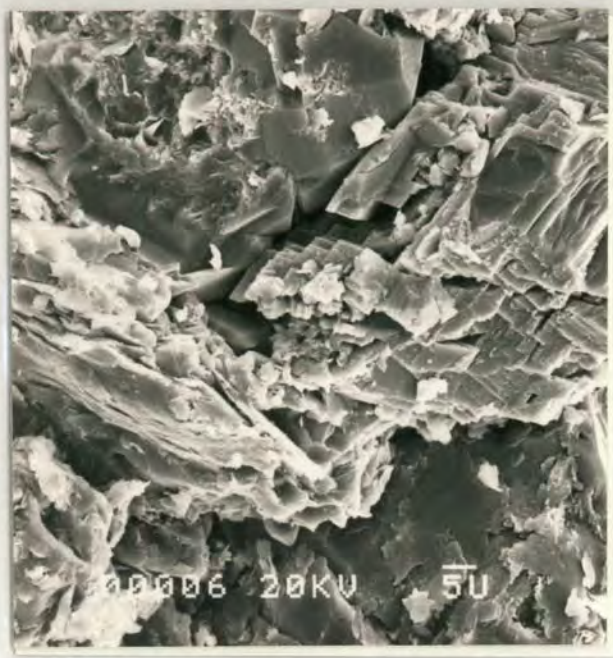
EXXON Pt. Thomson #2, 11774', Colville Shale, 2500X

A cluster of authigenic kaolinite books plugs the center of an intergranular pore.

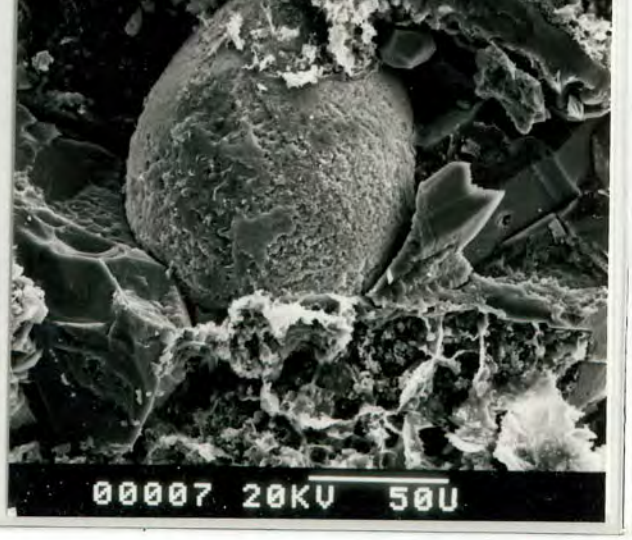
LOWER RIGHT

EXXON Pt. Thomson #2, 13124', Thomson Sand, 500X

Intergranular porosity has been destroyed by very extensive deformation of ductile micas and micaceous schist grains.


00006 20KV 5U


00006 20KV 50U


00007 20KV 50U


00008 20KV 5U

UPPER LEFT

EXXON Pt. Thomson #2, 13124', Thomson Sand 1000X

A detrital dolomite grain occurs on the right and a ductile mica grain on the left. A quartz overgrowth plugs the pore at the top.

UPPER RIGHT

FOREST Kemik #1, 4610-20', Kemik Ss., 400X

Sparse moderate-sized intergranular pores are still present in a sandstone cemented extensively by quartz overgrowths. Micropores occur in the partially dissolved chert grain at the center.

LOWER LEFT

FOREST Kemik #1, 4610-20', Kemik Ss. 500X

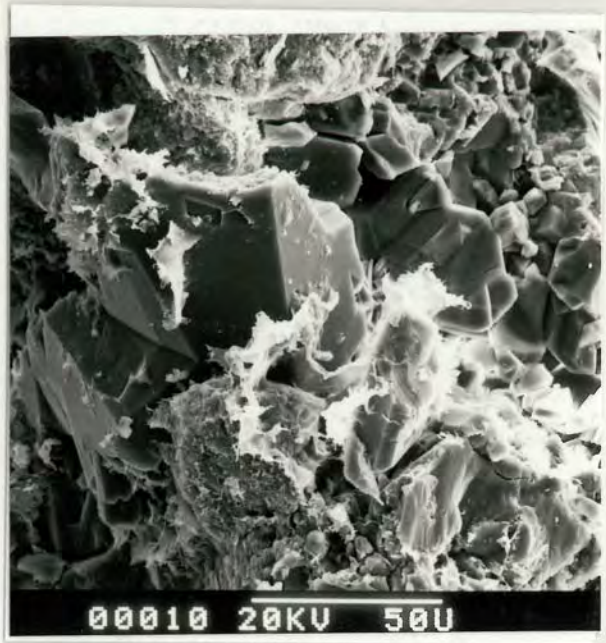
A phosphate grain containing very small micropores is surrounded by quartz overgrowths. A partially dissolved chert occurs at the upper left.

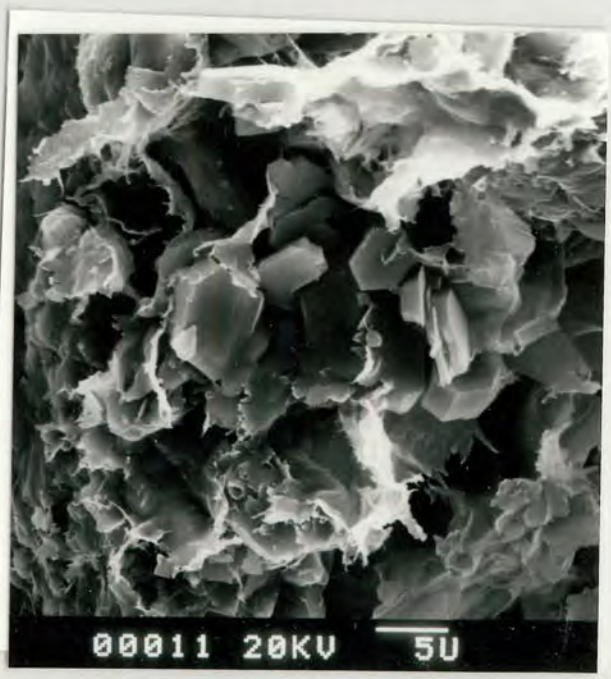
LOWER RIGHT

FOREST Kemik #1, 4610-20', Kemik Ss., 3000X

Stacks and fans of chlorite platelets plug the center of an intergranular pore. Such clays are common but not present in large amounts in this sample.


00009 20KV 50U


00010 20KV 50U


00011 20KV 5U


00012 20KV 5U

UPPER LEFT

FOREST Kemik #1, 4610-20', Kemik Ss. 200X

Minor amounts of moderate-sized intergranular pores are partially occluded by quartz overgrowths. A few partially dissolved chert grains with micropores also are present (center).

UPPER RIGHT

MOBIL Beli #1, 11836', Ivishak Ss., 700X

Illitic clays cover well-developed quartz overgrowths. The clays exhibit a curled flake morphology with elongate spines projecting from the edges.

LOWER LEFT

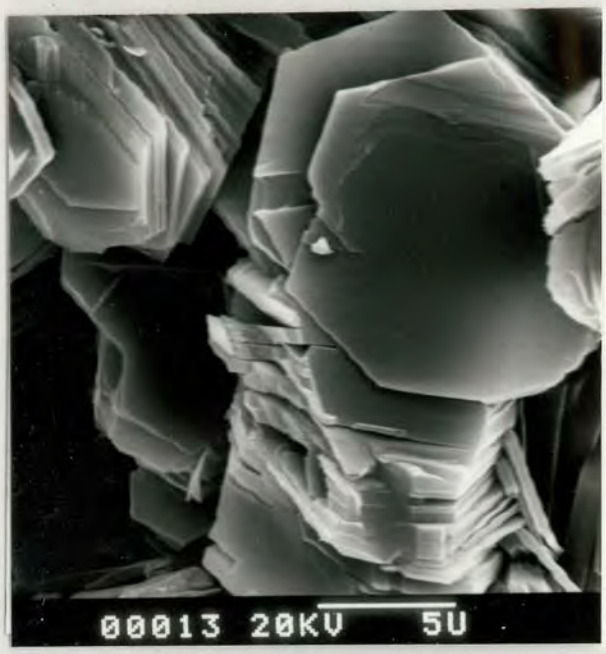
MOBIL Beli #1, 11836', Ivishak Ss., 2500X

Illitized kaolinite (book morphology) in the center of an intergranular pore. Kevex analysis indicates these clays contain high, silicon, minor aluminum and very minor potassium.

LOWER RIGHT

MOBIL Beli #1, 11836', Ivishak Ss., 4500X

A cluster of unillitized kaolinite books occurs in the center of the micrograph surrounded by illitic clays (top and bottom).


00013 20KV 5U


00014 20KV 50U


00015 20KV 5U


00016 20KV 5U

UPPER LEFT

MOBIL Beli #1, 11836', Ivishak Ss., 5000X

Books of kaolinite (Kevex analysis indicates only high silicon and aluminum) plug the center of a pore.

UPPER RIGHT

MOBIL Beli #1, 11836', Ivishak Ss., 300X

Only sparse large-and moderate-sized intergranular pores are present in a sandstone cemented extensively by quartz overgrowths.

LOWER LEFT

MOBIL Beli #1, 11836', Ivishak Ss., 1000X

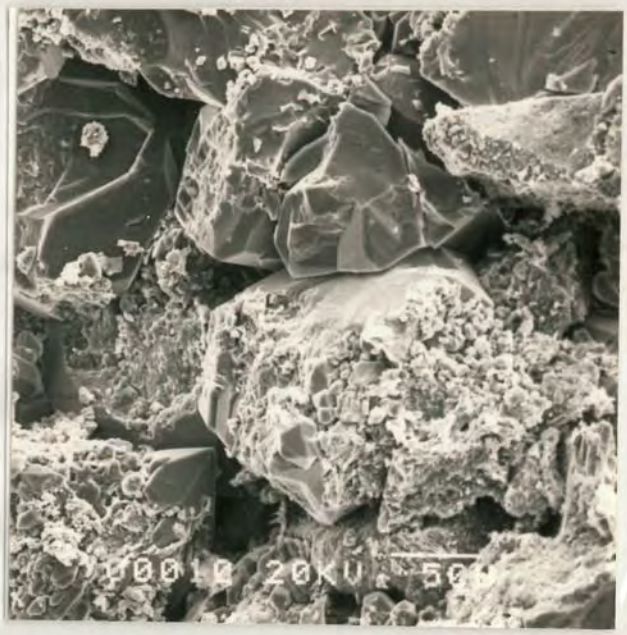
Quartz overgrowths extend to the center of an intergranular pore and have completely surrounded a cluster of authigenic kaolinite (center).

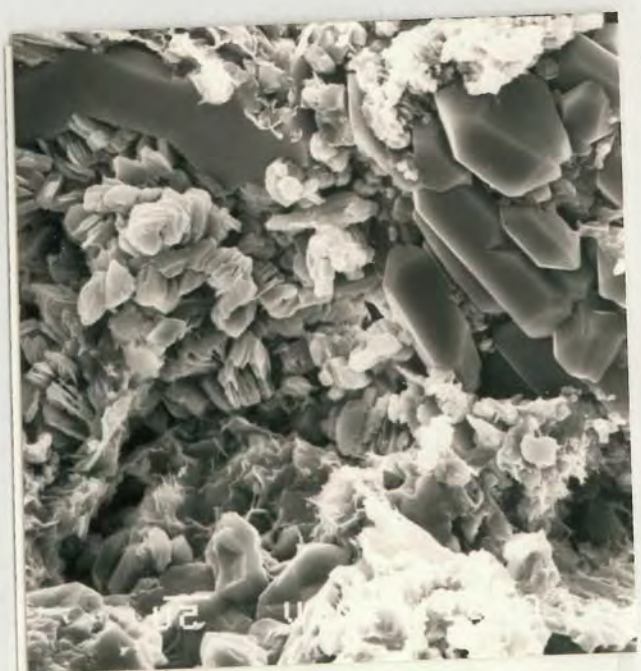
LOWER RIGHT

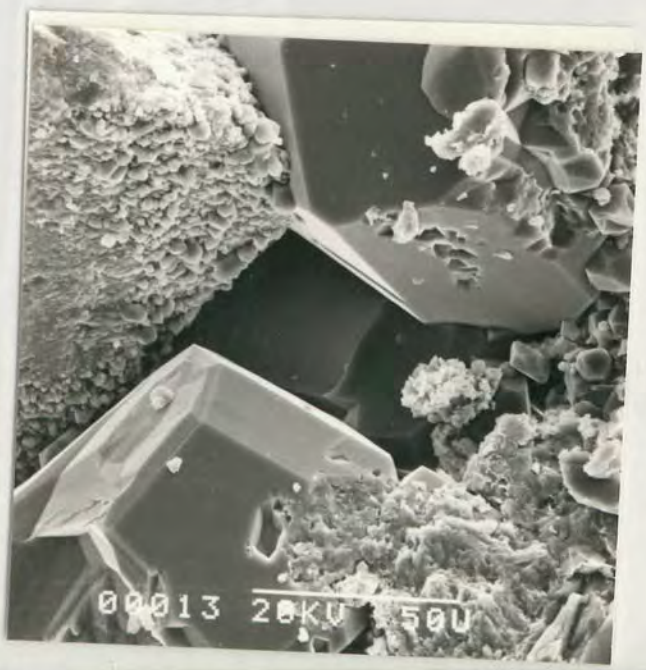
MOBIL Beli #1, 11836', Ivishak Ss., 3300X

Curled flakes of illite from which long spines project over a small quartz overgrowth.


00017 20KV 5U


00010 20KV 50U




00013 20KV 50U

UPPER LEFT

MOBIL Beli #1, 11836', Ivishak Ss., 4000X

Small rhombs of iron-rich dolomite (Kevex indicates high iron, minor to moderate magnesium and a trace of calcium) plug the center of a pore.

UPPER RIGHT

MOBIL Mikkelsen Bay State #13-9-19, 10618-19' Colville Ss., 250X

Large intergranular pores are present in a sandstone cemented primarily by quartz overgrowths. Kaolinite books occur in the center of some pores.

LOWER LEFT

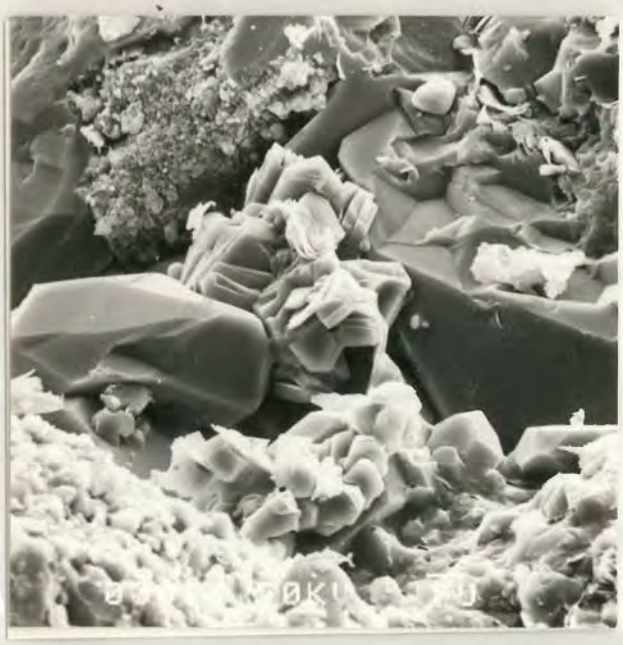
MOBIL Mikkelsen Bay State #13-9-19, 10618-19', Colville Ss., 1500X

A cluster of authigenic kaolinite books plugs the center of a pore. These books are partially enclosed in the outer portion of the adjacent quartz overgrowths.

LOWER RIGHT

MOBIL Mikkelsen Bay State #13-9-19, 10618-19', Colville Ss., 750X

Large quartz overgrowths (top and bottom) partially occlude an intergranular pore. Small overgrowths are present on the chert grain at the upper left.




20KV 50U


20KV

UPPER LEFT

MOBIL Mikkelsen Bay State #13-9-19, 11697-98', Thomson Sand, 1300X

A cluster of authigenic kaolinite books occurs in the center of a pore and are surrounded by large quartz overgrowths.

UPPER RIGHT

MOBIL Mikkelsen Bay State #13-9-19, 11697-98', Thomson Sand, 500X

Modest amounts of intergranular pores are present in a sandstone with extensive quartz overgrowth developmeent and a few patches of authigenic kaolinite books (center).

LOWER LEFT

MOBIL W. Staines #18-9-23, 7754-55', Sagavanirktok Fm., 800X

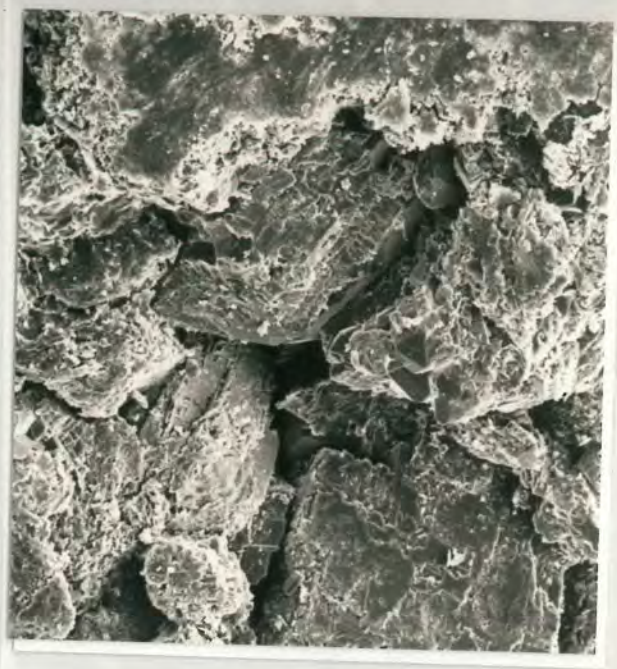
Extensive ductile deformation of micas and micaceous schist fragments has destroyed the bulk of the intergranular porosity.

LOWER RIGHT

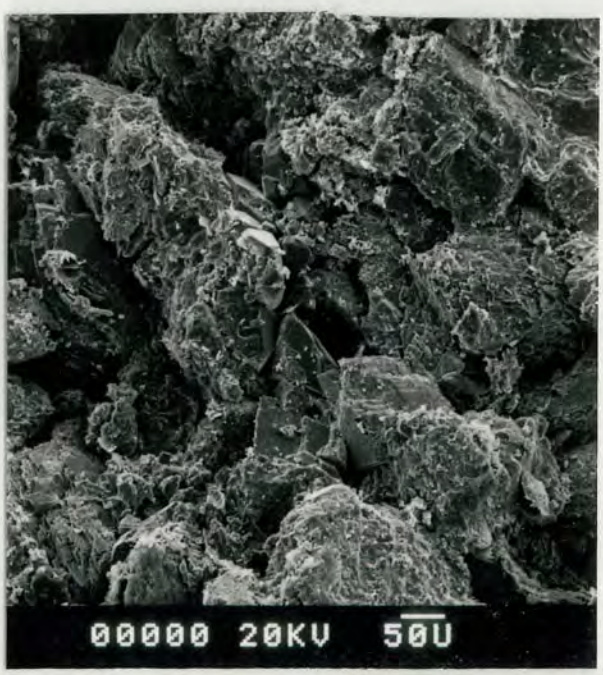
MOBIL W. Staines #18-9-23, 12559-60', Colville Shale, 1300X

Zeolite has replaced a glass shard (smooth surface) in a tuffaceous deposit. A Kevex pattern indicates high silicon, moderate aluminum, minor (but unusually high sodium) and a trace of calcium.


00017 20KV 50U




00020 20KV 50U


00000 20KV 50U

UPPER LEFT

SOHIO Challenge Island #1, 13444', Thomson Sand, 150X

Large intergranular pores are common in a sandstone containing abundant detrital dolomite. Quartz overgrowths occlude a minor amount of the pore space.

UPPER RIGHT

SOHIO Challenge Island #1, 13444', Thomson Sand, 200X

Detrital dolomite grains occur at the bottom and quartz grains with overgrowths at the top. Note the large intergranular pores.

LOWER LEFT

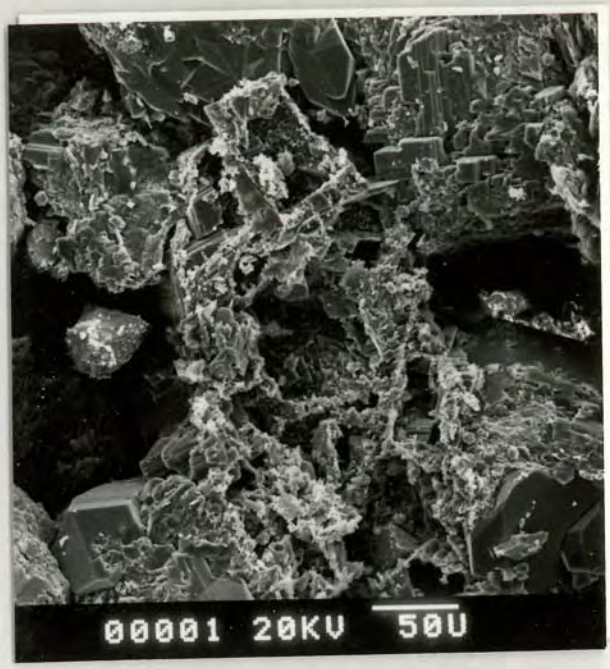
SOHIO Challenge Island #1, 13444', Thomson Sand, 900X

Rhomb-shaped projections on the surface of this dolomite grain may represent either overgrowth projections or solution facets.

LOWER RIGHT

SOHIO Challenge Island #1, 13449', Thomson Sand, 150X

Large intergranular pores are present in a sandstone containing abundant detrital dolomite. Quartz overgrowths partially occlude a few pores.



Solio #1 Challenge Dr.

13444'

Roll 4 Neg 17

UPPER LEFT

SOHIO Challenge Island #1, 13449', Thomson Sand, 300X

A detrital dolomite fragment (center) has been partially dissolved. Such porosity does not contribute significantly to the total porosity. Quartz overgrowths are present on grains at the top center and bottom of the micrograph. Note the large intergranular pores at right and left.