Petrographic analysis and formation damage potential of core plugs (12,017' - 12,037') from the Husky NPR Operations Seabee Test Well No. 1.

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PETROGRAPHIC ANALYSIS AND FORMATION DAMAGE POTENTIAL OF CORE PLUGS, 12017-12037', HUSKY SEABEE #1, NORTH SLOPE, AK

James J. Hickey S93-06
January, 1993

- CONFIDENTIAL -

DATE: January 15, 1993

SUBJECT: **Petrographic analysis and formation damage potential of core plugs, 12017-12037', Husky Seabee #1 (offset to Big Bend prospect), North Slope, AK** **S93-06**

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Thin sections (Plates 1-3) and X-ray diffraction analyses (Table 1) from three 1" plugs (12017-37') cut from conventional core in a zone of interest in the Husky Oil #1 Seabee (an offset analogue to a target of the Big Bend prospect, currently drilling) have been examined to identify potential formation damage mechanisms, as a screening tool for possible further fluid-flow testing, and to document controls on reservoir quality. The sandstones are generally only lightly-cemented with little clay matrix, but are silty, only moderately-sorted, strongly compacted with abundant ductile lithic grains: pores are scarce, small, and poorly-connected, and inferred permeabilities are quite low (air perms of a few millidarcies or less). XRD analysis indicates that chlorite and illite are the only clay phases present, and these occur in large part as lithic (sedimentary and metasedimentary) sand grains. Mobile fines and swelling clays do not present any significant potential for formation damage in such sands. These particular samples probably do not represent oil pay. As a result, critical rate tests have not been performed for these plugs.

The sandstones are typically fine-grained, silty, clean to slightly shaly, moderately-sorted, closely-packed (low remnant intergranular volumes), and lightly-cemented by patchy siderite spar, incipient quartz overgrowths, pore-lining chlorite, and framboidal pyrite. Detrital composition is dominated by quartz (commonly quite angular) with common feldspars, detrital dolomite, and shaly/phyllitic rock fragments (usually slightly to moderately squashed). Good reservoir-quality rocks will be better-sorted and more quartzose than these (a function of depositional setting, and certainly within the realm of possiblity). Sandstones similar in texture and compositon to these samples are liable to be of poor to moderate reservoir quality at best. Formation-damage concerns in such sands include mechanical stability (sand production from poorly-cemented beds, formation compressibility due to pressure depletion) and capillary blocking (lost k_{ro} due to filtrate flushing, slow and difficult to recover due to adverse capillary properties of small, poorly-connected pores). For the purposes of an initial production test, the relative permeability problems are the main concern. Mitigation strategies include low fluid-loss mud with minimum overbalance, minimum exposure time of the interval of interest to the mud column, high underbalance during perforating and high drawdowns during flow, use of a surfactant additive in the completion fluid to encourage flowback, prolonged flow periods, and hydraulic fracturing beyond the invaded zone (which would have the added advantage of offsetting the limited native permeability). Poor initial test results should be diagnosed in light of the probable character of this interval (if available, rotary SWC's would permit quick petrographic and core flow-test input to the well test evaluation). Please call if you would like to discuss these interpretations further.

James J. Hickey

cc: D. Underdown PRC D3224

TABLE 1.
XRD ANALYSIS
HUSKY #1 SEABEE
NORTH SLOPE, AK

SAMPLE DEPTH	12017'	12031'	12037'
WHOLE ROCK MINERALOGY			
QUARTZ	58	55	63
PLAGIOCLASE	20	16	20
K-FELDSPAR	4	3	4
FE-DOLOMITE	2	1	1
DOLOMITE	2	3	3
SIDERITE	1	2	TR
PYRITE	0	0	TR
TOTAL SHEET SILICATES	14	19	9
TOTAL	*101*	*99*	*100*
SHEET SILICATES (CLAYS + MICAS)			
ILLITE & MICA	30	36	18
CHLORITE	70	64	82
KAOLINITE	0	0	0
TOTAL	*100*	*100*	*100*

All values are weight %, normalized to total dry rock (whole rock mineralogy) or to clay-mineral fraction only (sheet silicates). TR = trace amount (<1%). Totals other than 100% are due to rounding errors. Analysis by J. Genuise (754-6098).

PLATE 1 **Husky Seabee #1**

12017'

SANDSTONE, very fine to fine-grained, silty, moderately to moderately well-sorted, close-packed with little intergranular volume, moderate planar fabric, only minor detrital clay matrix. Lightly-cemented by small patches of carbonate spar, traces of incipient quartz overgrowths, small pyrite framboids, and pore-lining chlorite. Angular quartz grains common. Scattered small (< 20 microns) intergranular pores and subordinate isolated intragranular pores. Detrital grains derived from metamorphic and carbonate terranes: monocrystalline and polycrystalline quartz, plagioclase (fresh, albite-twinned), K-feldspar (albitized?), mica (muscovite, chlorite, biotite), detrital carbonate (dolomite spar, micritic fragments), argillaceous sedimentary and metasedimentary rock fragments (common), tourmaline. Shaly/phyllitic rock fragments are slightly to moderately squashed, occasionally microporous and/or altered to kaolinite.

XRD mineralogy estimates:
58% quartz, 24% feldspars, 4% carbonate, 14% clays + mica (chlorite > illite/mica)

PHOTO	DESCRIPTION
A	Strongly-compacted, poorly-cemented, silty very fine to fine-grained sandstone with common argillaceous lithic fragments (brownish grains) and rare, isolated macropores (A5, F5).
B	Close-up of silty sandstone with incipient quartz overgrowths between grains and small remnant intergranular pores (C5, E3, E6, G7), commonly with thin linings of authigenic chlorite. Note argillaceous rock fragment (F5) and scattered detrital carbonate crystals (E4, F4, I1). A pore system such as this is liable to exhibit a very high irreducible water saturation, poor relative oil permeability, high entry pressure for drainage, and a propensity for damage by capillary blocking due to filtrate invasion.

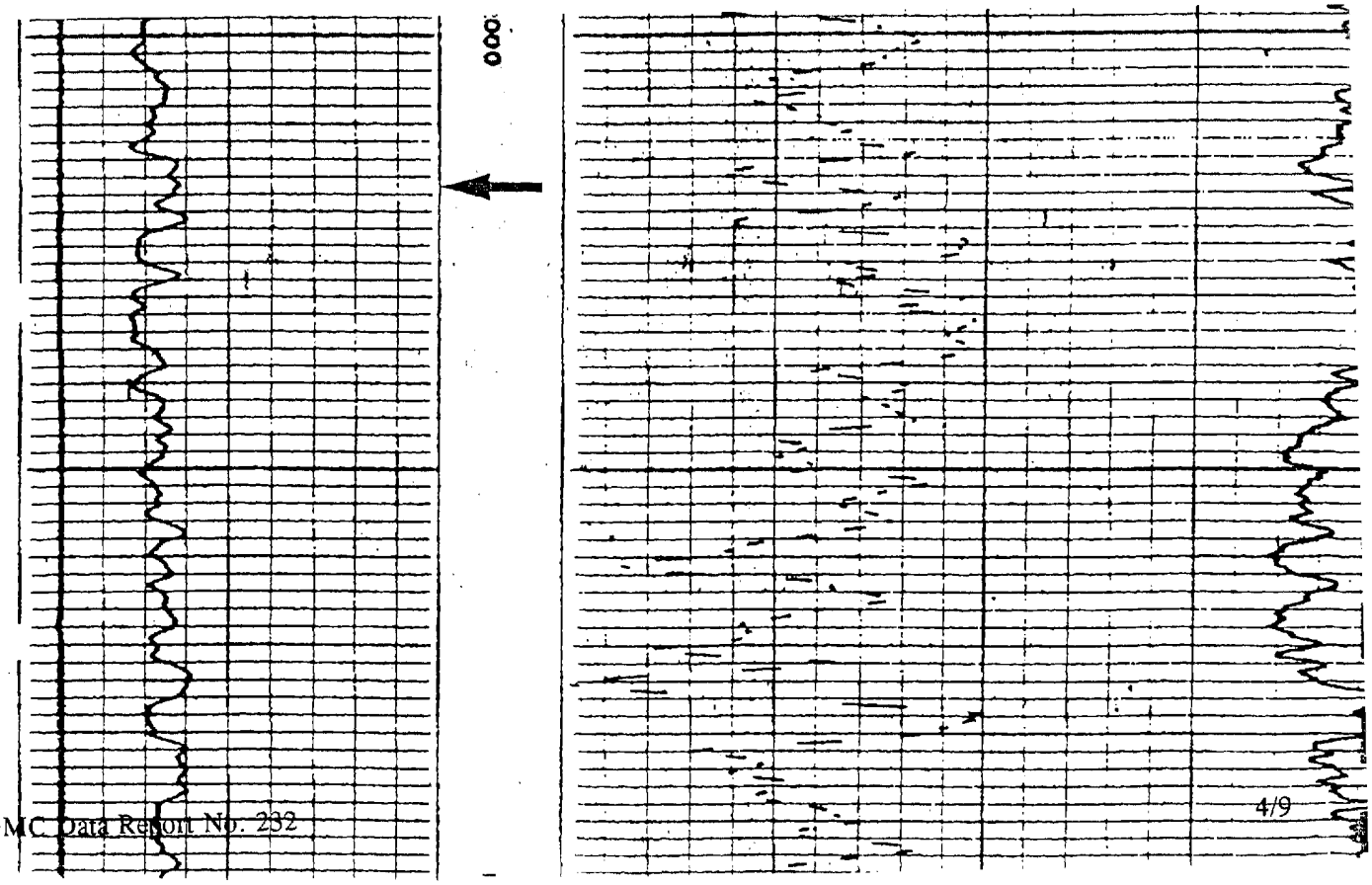


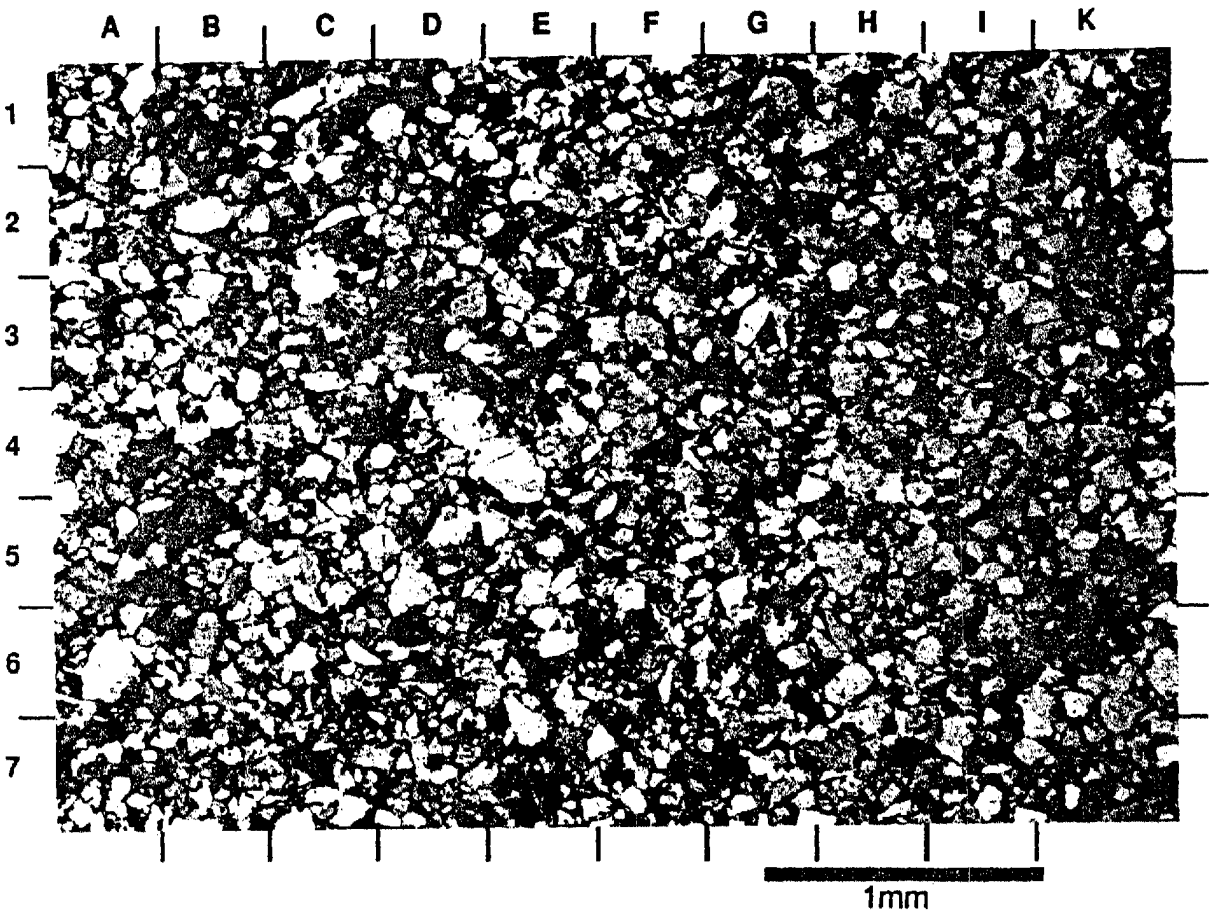
PLATE 1

HUSKY #1 SEABE

NORTH SLOPE, AK

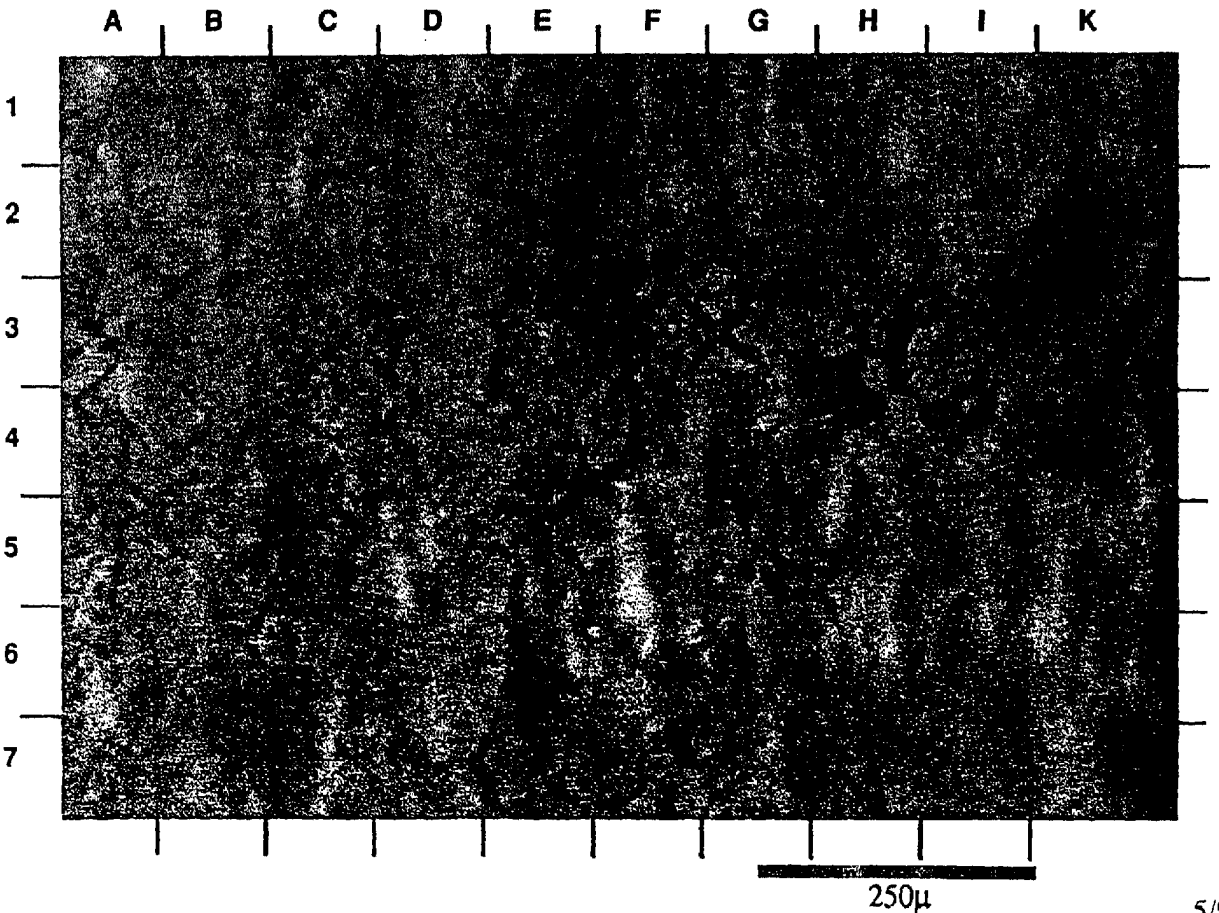
A

12017'



B

12017'



12031'

SANDSTONE, fine-grained (range very fine to medium), silty, slightly shaly, moderately-sorted, close-packed, strong planar fabric, with minor small (1 mm diameter) vertical burrows(?). Most grains subangular. Porosity consists of scattered, poorly-connected small intergranular pores, isolated intragranular pores, and microporous argillaceous grains and matrix. Lightly-cemented by traces of incipient quartz overgrowths, microcrystalline pyrite, pore-lining chlorite, late siderite rhombs. Similar metamorphic/carbonate provenance as 12017': monocrystalline and polycrystalline quartz, ductile argillaceous sedimentary and metasedimentary rock fragments, detrital carbonate (some appears ferroan), feldspars (some leaching of plagioclase), muscovite, chlorite, mafic volcanic fragments (microporous), zircon, sphene, carbonaceous organic debris (pyritized). Burrows(?) are enriched in coarser quartz sand (argillaceous matrix and grains have been excluded) and extensively-cemented by quartz overgrowths (with some large late carbonate rhombs).

XRD mineralogy estimates:
55% quartz, 19% feldspars, 7% carbonate, 19% clays + mica (chlorite > illite/mica)

PHOTO	DESCRIPTION
A	Silty, well-compacted, lithic-rich sandstone (B4, K4) punctuated by a small burrow(?), D1-H7, that is much more quartzose and extensively cemented by quartz overgrowths. Dark grains are argillaceous lithic fragments (sedimentary and metasedimentary). Macropores are rare and isolated.
B	Closely-packed, slightly shaly sandstone with minor intergranular microporosity and isolated intragranular pores (C4, partially-leached plagioclase) and microporous rock fragments (basaltic volcanic clast at K7). Porosity and permeability of this sandstone are quite low.

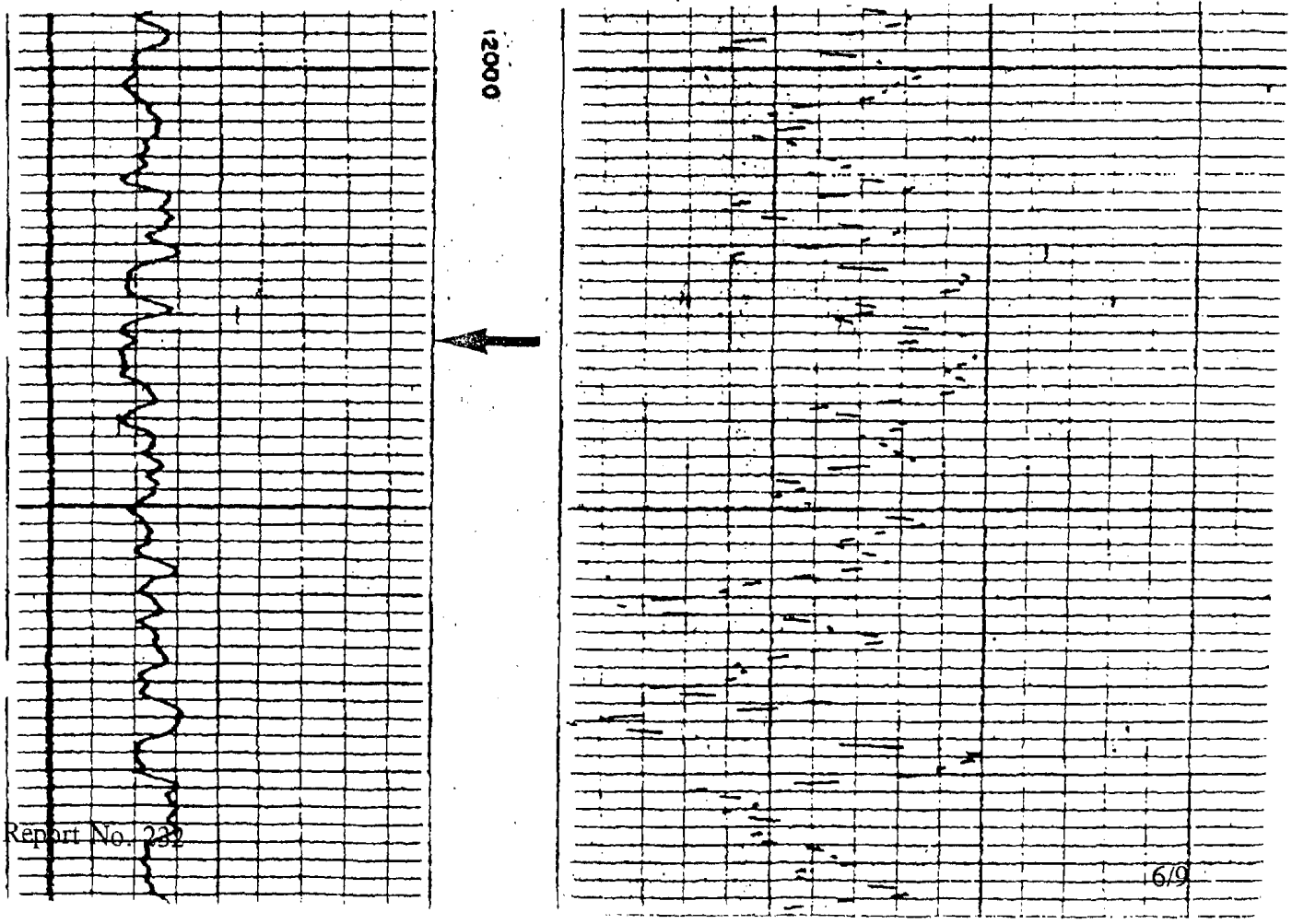


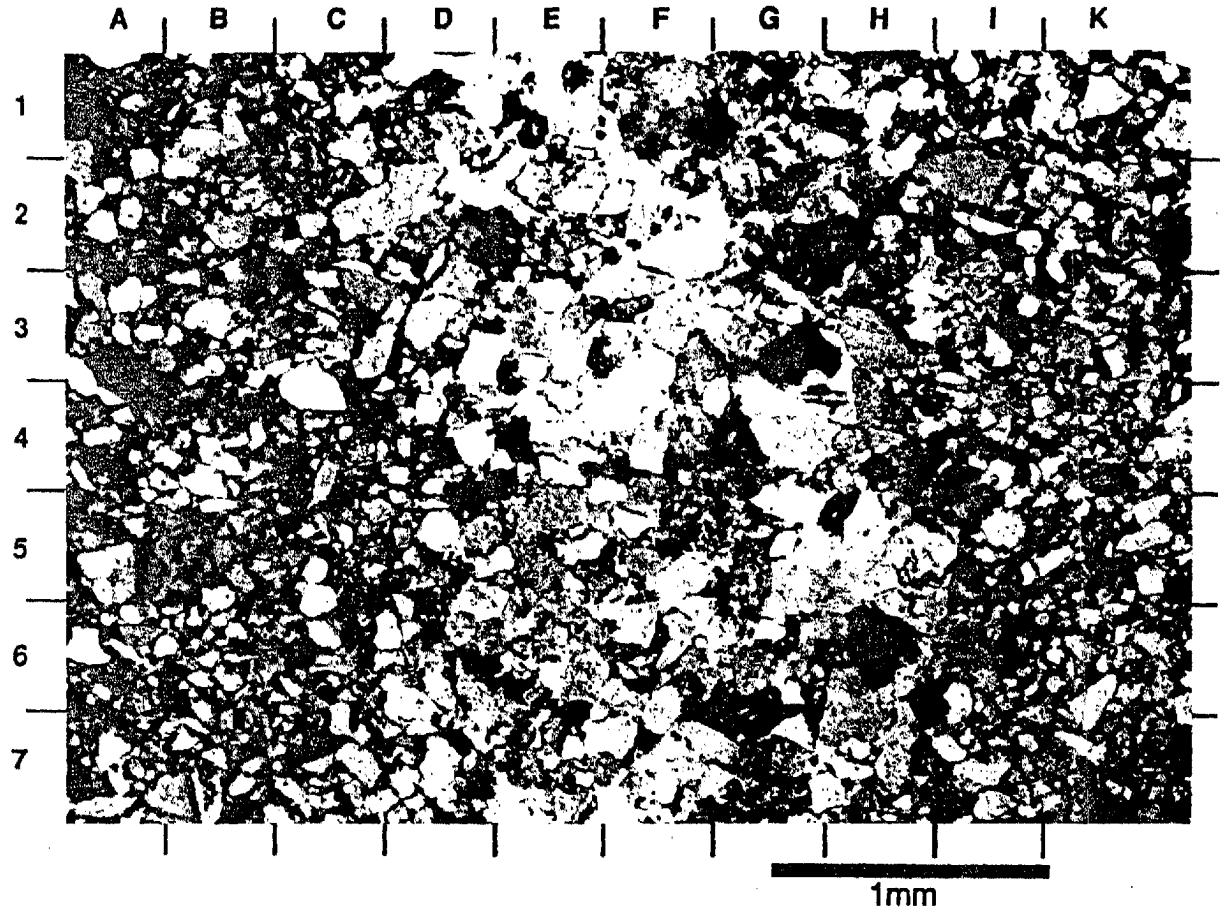
PLATE 2

HUSKY #1 SEABEE

NORTH SLOPE, AK

A

2031'



B

)31'

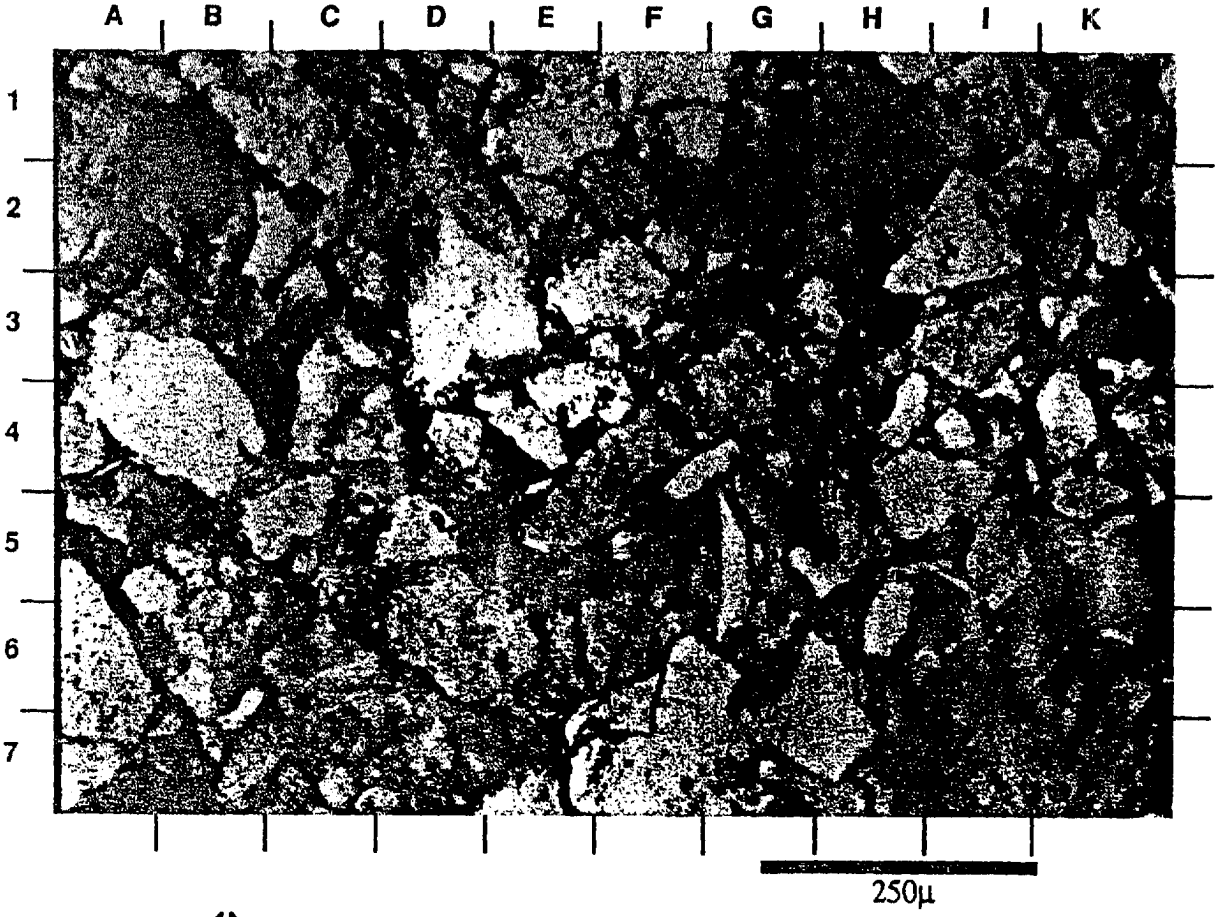


PLATE 3 **Husky Seabee #1**

12037'

SANDSTONE, very fine to fine-grained (occasionally to medium), slightly silty, slightly shaly, moderately well-sorted, close-packed; faintly/diffusely-bedded, poor to moderate planar fabric. Slightly coarser, better-sorted, better-cemented (quartz) than 12017' and 12031'. Light to moderate patchy (0.5-1 mm) cementation by quartz overgrowths, sparry carbonate, large pyrite framboids and aggregates; traces of pore-lining chlorite. Common dead oil as thin interstitial films. Metamorphic/carbonate provenance: monocrystalline and polycrystalline quartz, argillaceous sedimentary and metasedimentary rock fragments (ductile, micaceous), detrital carbonate, plagioclase (mostly fresh, albite-twinned), K-feldspar (albitized?), chert, tourmaline.

XRD mineralogy estimates:
63% quartz, 24% feldspars, 4% carbonate, 9% clays + mica (chlorite >> illite/mica)

PHOTO	DESCRIPTION
A	Lightly-cemented but strongly-compacted lithic-rich (common dark argillaceous grains) sandstone with scattered interstitial coatings of dead oil but no visible macroporosity.
B	Close-up of tightly-packed sand grains with incipient quartz overgrowths and black wisps of dead oil lining many grain contacts. If oil charging post-dates most of the compaction visible here, quite high capillary entry pressures (and thick oil columns) are implied by the presence of oil in such small pores in a tight sandstone.

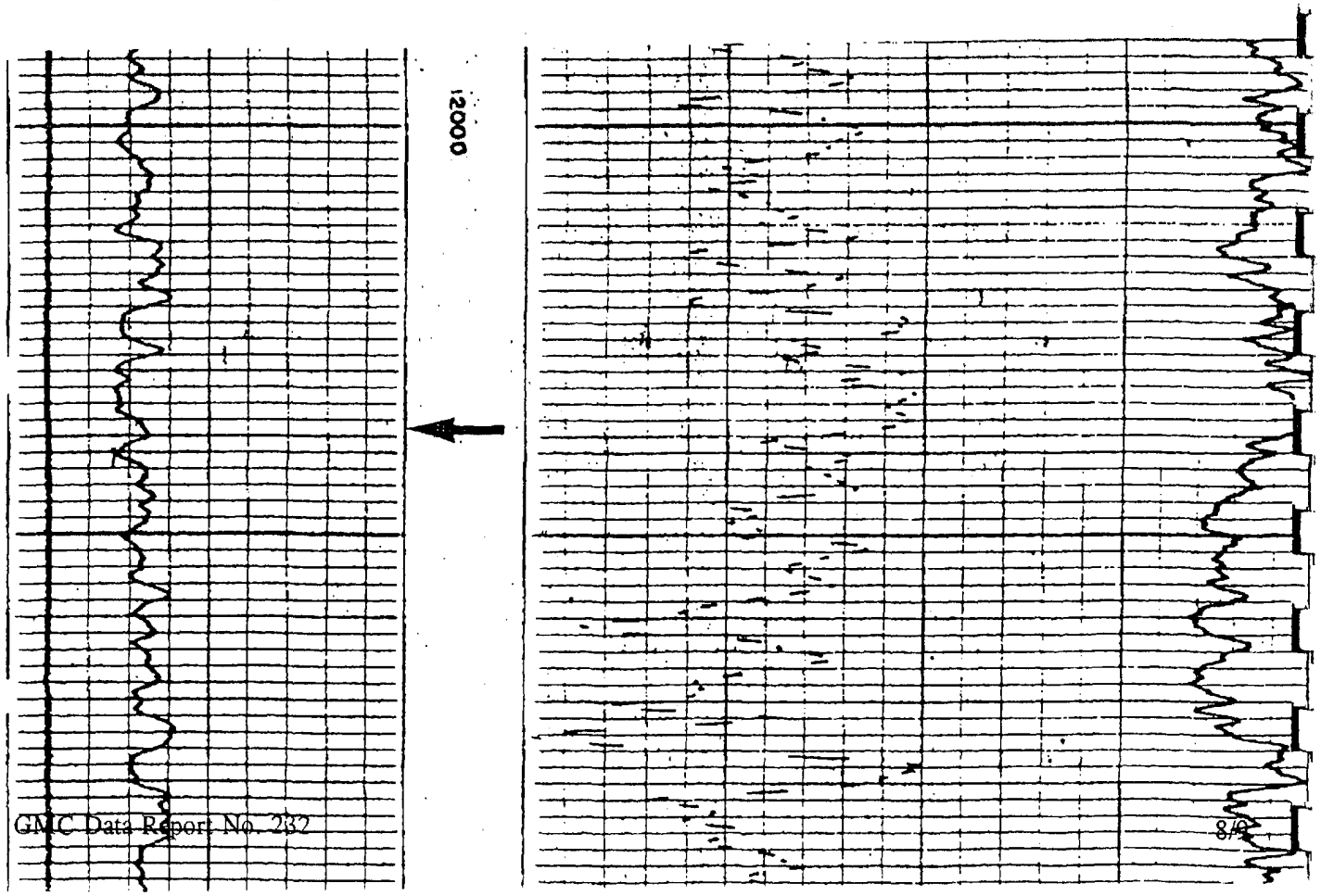


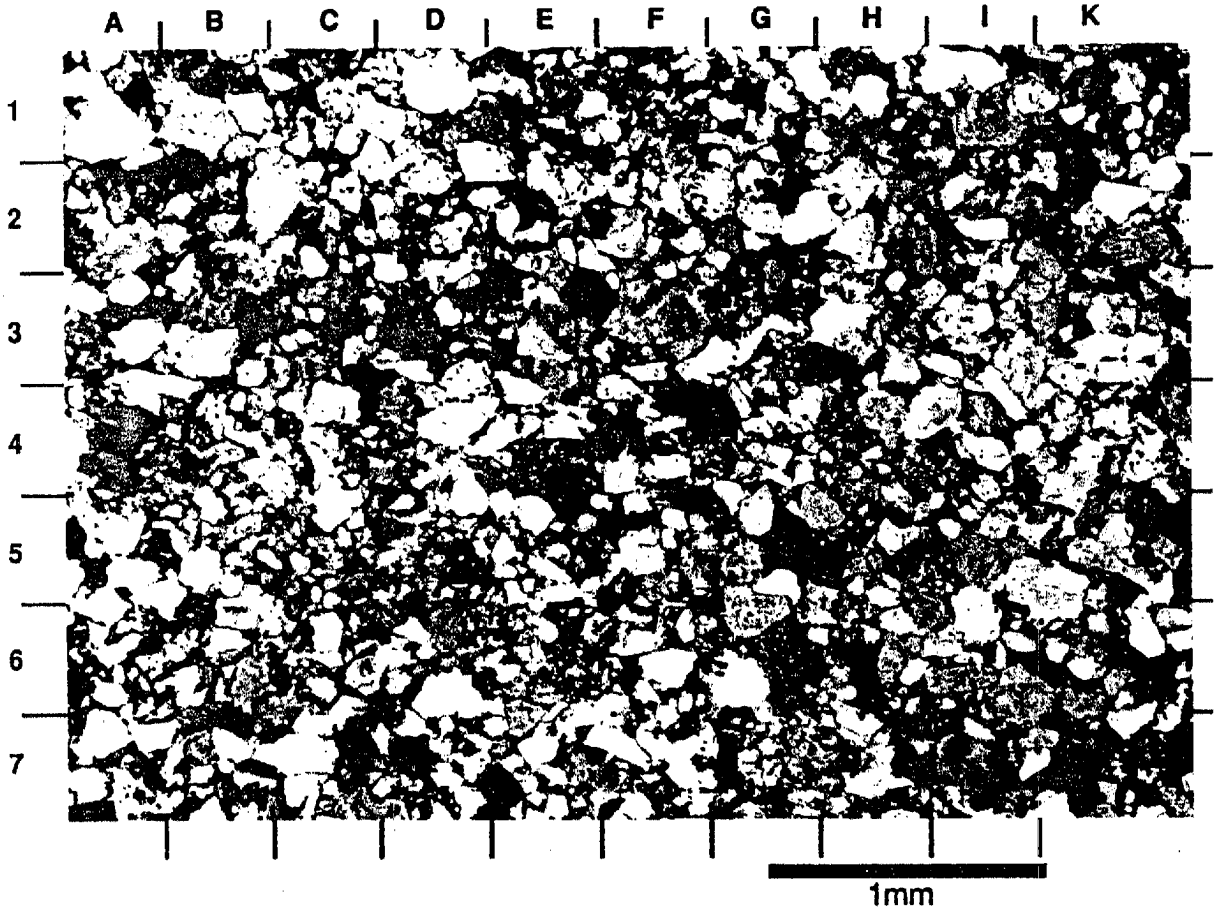
PLATE 3

HUSKY #1 SEABEE

NORTH SLOPE, AK

A

12037'



B

12037'