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GROUT INFILTRATION IN FERNALD ENVIRONMENTAL MANAGEMENT PROJECT MONITORING WELLS

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REPORT

Department of Energy
Fernald Environmental Management Project
P. O. Box 398705
Cincinnati, Ohio 45239-8705
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JAN 31 1995

DOE-0443-95

Mr. James A. Saric, Remedial Project Manager
U.S. Environmental Protection Agency
Region V-5HRE-8J
77 W. Jackson Blvd.
Chicago, Illinois 60604-3590

Mr. Tom Schneider, Project Manager
Ohio Environmental Protection Agency
401 East 5th Street
Dayton, Ohio 45402-2911

Dear Mr. Saric and Mr. Schneider:

GROUT INFILTRATION IN FERNALD ENVIRONMENTAL MANAGEMENT PROJECT MONITORING WELLS

Downhole camera surveys conducted on monitoring wells at the Fernald Environmental Management Project (FEMP) observed grout infiltration in the screens of several wells. As a result of this observation the Department of Energy, Fernald Area Office (DOE-FN) initiated an investigation to determine the impact of the grout on water quality analyses, and to determine the cause of the infiltration.

Enclosed is a letter report summarizing the results of the investigation, and a recommendation for modification to the monitoring well installation procedures in the Site-wide CERCLA Quality Assurance Project Plan (SCQ).

If you have any questions, please contact Kathi Nickel at (513) 648-3166.

Sincerely,

Johnny Reising

for Jack R. Craig
Fernald Remedial Action
Project Manager

FN:Nickel

Enclosure: As Stated

Recycled and Recyclable

cc w/enc:

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D. R. Koslowski, EM-42/QO
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AR Coordinator, FERMCO

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R. L. Glenn, Parsons
J. W. Thiesing, FERMCO

SUMMARY OF MONITORING WELL INTEGRITY INVESTIGATION (GROUT CONTAMINATION)

Introduction

The possibility of grout contamination in monitoring wells at the Fernald Environmental Management Project (FEMP) was realized when down hole camera surveys observed four wells (2435, 3425, 3435, and 4425) that had grout seeping into the well screens. Uncertainty regarding the effect of this material on water chemistry resulted in the plugging and abandonment of these wells, and the initiation of a well integrity investigation.

The investigation targeted a select group of wells that exhibit various maintenance problems (i.e. well identified as having muddy bottoms or having sediment buildup). Activities performed under this investigation were intended to identify:

- Whether bentonite grout used during well installations infiltrated monitoring well screens as a result of well design or installation technique;
- The effect of bentonite grout on groundwater analytical results.

Discussion

A consortium of Ohio universities was asked to review the situation and make an independent recommendation. The consortium recommended x-ray diffraction analysis of "suspect" material encountered in the wells, and of the bentonite grout used during well installation. X-ray diffraction is an analytical method that determines the mineral composition of geologic materials. The University of Cincinnati (UC) was chosen to perform this analysis due to their close proximity to the FEMP, and short turn-around time for completing the analysis.

The following samples were sent for analysis:

- Volclay™ grout: the brand of bentonite grout used at the FEMP;

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- Material collected from the silt traps from 24 wells identified as having potential maintenance problems;
- Prepurge and postpurge groundwater samples from 3 of the 24 wells (3417, 3432, and 41217)
- Native material from the Great Miami Aquifer.

Prepurge and postpurge samples were collected to identify the minerals suspended in the groundwater, and to evaluate whether the presence of these minerals impacts water quality results. X-ray diffraction is limited to the analysis of solid material, therefore, analyses were limited to wells that yield turbid samples (3417, 3432, and 41217). The water samples were filtered, and X-ray diffraction performed on the sediment trapped on the filter paper. Groundwater samples from the remaining 21 wells were free of turbidity, and therefore, did not yield sediment for X-ray diffraction analysis.

The following conclusions were reached from the analysis:

- Volclay™ grout is comprised of sodium montmorillonite a member of the smectite group of clay minerals.
- The native sediments of the Great Miami Aquifer contain no smectite.
- Sediment collected from the silt traps from 12 of the 24 wells contained smectite.
- On average, smectite accounted for approximately 8 percent of the material found in the silt traps of 11 of the 12 wells containing grout.
- The twelfth well (41217), had a higher percentage of smectite in its silt-trap material, and smectite was detected in the prepurge and postpurge groundwater samples collected from this well.
- Minimal or nonexistent amounts of smectite were detected in remaining two prepurge and postpurge groundwater samples (3417 and 3432).

The percentage and presence of grout contamination in the wells evaluated are indicated in Figures 1 and 2, respectively. Attachment I contains example pie charts of x-ray diffraction results from several wells included in this investigation.

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Geochemical Evaluation

An expert in the field of geochemistry was asked to evaluate analytical results from the wells to determine the effect of grout contamination on water chemistry. Provided in Attachment II is a report by Dr. Rich Abitz from International Technologies, Inc. who concluded that the FEMP's Contaminants of Concern (COC's) should not be significantly affected by the presence of grout (montmorillonite) in the wells. Dr. Abitz explained that the exchange affinity for the sodium montmorillonite sites is highest for divalent cations and that these exchange sites will be preferentially occupied by the more abundant divalent cations of calcium and magnesium present in the Great Miami Aquifer. Other divalent cations may also exchange for sodium, but their affinity for exchange is many orders of magnitude lower than calcium and magnesium. The lower affinity for these divalent cations is primarily due to their relative concentrations in the Great Miami Aquifer. Additionally, it is unlikely that monovalent cations will be effected and that adsorption of neutral and negative aqueous complexes should not be significant. From his review and that of university personnel, it was concluded that concentration of constituents of concern in FEMP groundwater should not be affected by the observed levels of grout contamination.

Although the results of the X-ray diffraction analysis and geochemical evaluation determined that the presence of grout did not compromise the utility of the wells, the cause of the grout infiltration was investigated. It was initially thought that grout contamination of wells 2435, 3425, 3435, and 4425 (the four wells initially plugged and abandoned) was the result of the well installation procedures used during the project. These wells were installed under strict adherence with the Technical Enforcement Guidance Document which include a sand pack that extends two feet above the well screen. Sand packs in wells installed under other FEMP projects extend five or more feet above the well screen. It was suspected that two feet of sand above the well screen was insufficient for preventing grout infiltration. As part of this investigation all components of

well design and installation were reviewed including:

- Sandpack length above well screen
- Sand and slot sizes
- Grout preparation and installation
- Use of bentonite seals.

The comparison of wells 2435, 3425, 3435, and 4425 to well with longer sand packs revealed that grout infiltration occurred regardless of the length of the sandpack. The review could not correlate the presence of grout directly to any specific installation error or technique.

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CORRECTIVE ACTIONS

Due to the findings of this investigation, the following actions will be taken:

- Stringent quality assurance checks will be performed, including verification of grout viscosity prior to and following grout placement, use of a side discharge tremie pipe during grout placement, verification of boring depth and dimensions (i.e. sandpack, screen, grout), and verification of volume calculations and actual volumes used (i.e. sand and grout) will be conducted.

- Wells identified as containing grout will be redeveloped.

- Evaluation of groundwater analytical results from effected wells will be conducted on an annual basis.

Although this investigation was unable to link the presence of grout to well installation procedures, it is recommended that installation procedures for wells installed in the Great Miami Aquifer be modified as follows:

- Type 2 well installation procedures have been determined to be satisfactory (i.e. grout infiltration is not prevalent in type 2 wells), therefore no modification is recommended. Type 2 wells include a bentonite pellet seal which appears to adequately prevent grout infiltration.

- Native sediments of the Great Miami Aquifer will be permitted to collapse around the borehole of Type 3 wells (wells which do not penetrate the clay interbed) up to the water table following placement of the well screen, riser pipe, and sand pack. A bentonite pellet seal will be placed immediately above the water table and grout will be tremied to the ground surface.

- Native sediments of the Great Miami Aquifer will be permitted to collapse around the borehole of Type 4 wells (wells which are advanced through the clay interbed) up to the bottom of the clay interbed following placement of the well screen, riser pipe, and sand pack. The borehole will then be grouted from the bottom of the clay interbed to the ground surface.

- The borehole of Type 4 wells (wells which are installed in areas where the clay interbed is absent) will be installed consistent with the procedures recommended above for Type 3 wells.

The recommended modifications will not adversely impact the quality of ground water samples collected from wells installed

via the modified procedures. The use of grout in monitoring well installation is intended to eliminate the potential for the annular space to act as a preferential pathway permitting vertical migration of groundwater between zones in the aquifer. The potential for the annular space to act as a preferential pathway is of concern in an environment where the surrounding sediments are of relatively low permeability. However, given the high permeability of the Great Miami aquifer materials, vertical mixing within the aquifer is not limited by a confining zone. Grout placed around the riser pipe during well installation, therefore, provides little, if any, barrier to vertical migration within the aquifer. The revised well installation procedures noted above will prevent contaminants from the glacial overburden (i.e. a confining zone) from preferentially migrating through the annular space, as well as eliminate any possibility of grout intrusion into monitoring wells.

Lastly, although well 41217 was originally identified as containing a significant amount of grout, recent data has indicated that the grout contamination has dissipated. Grout contamination first appeared during the third quarter of the 1994 RCRA sampling event, but was not encountered during the fourth quarter. This well will be reevaluated after the first quarter of 1995 sampling. If in the future a significant amount of grout is detected additional action will be evaluated.

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ATTACHMENT I

ATTACHMENT II

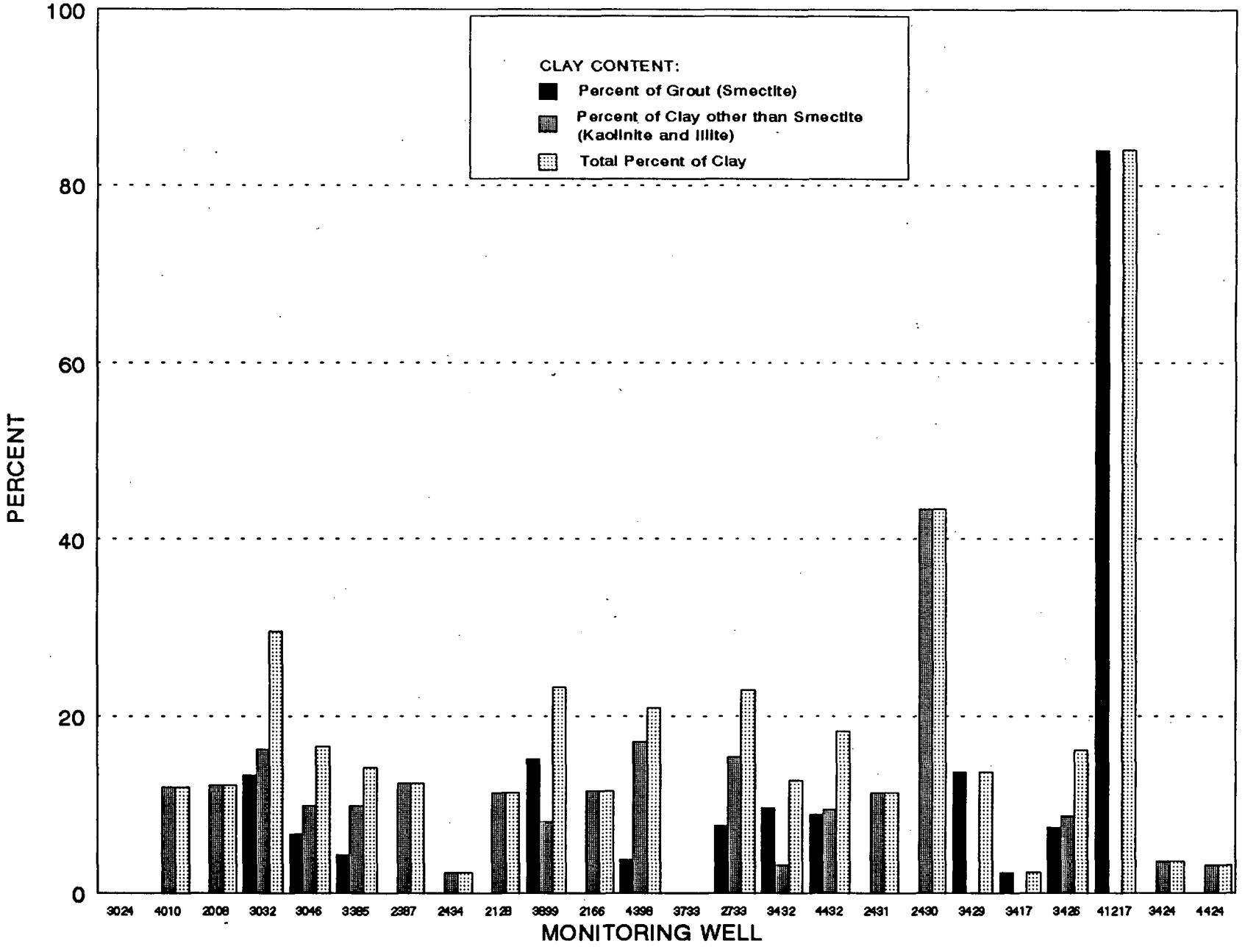

FIGURE 1. CONTENT OF CLAY IN SILT TRAP MATERIAL

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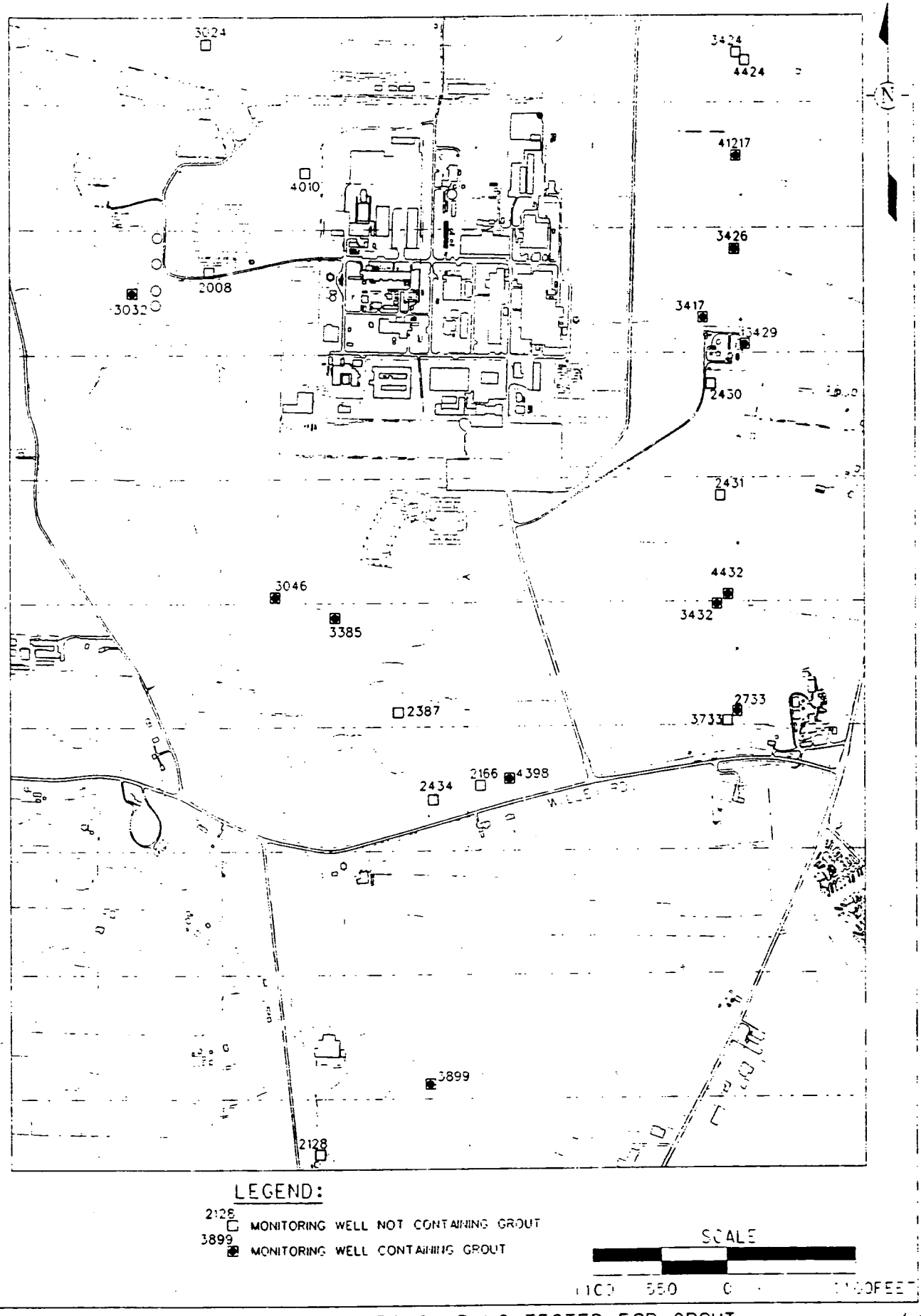

FIGURE 2. MONITORING WELLS TESTED FOR GROUT

ATTACHMENT I

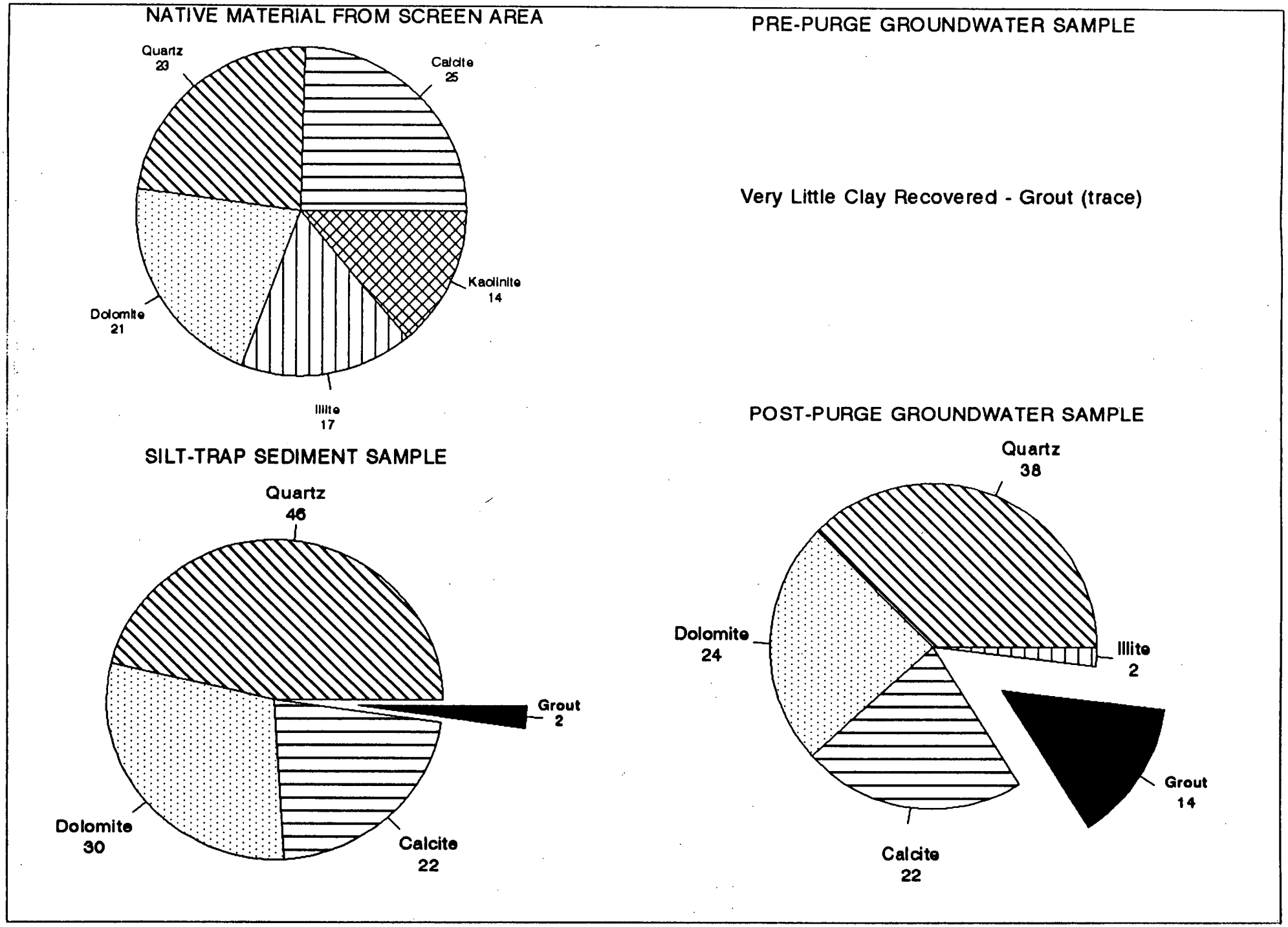

FIGURE 1. MINERALOGY OF SAMPLES FROM MONITORING WELL 3417 IN PERCENT

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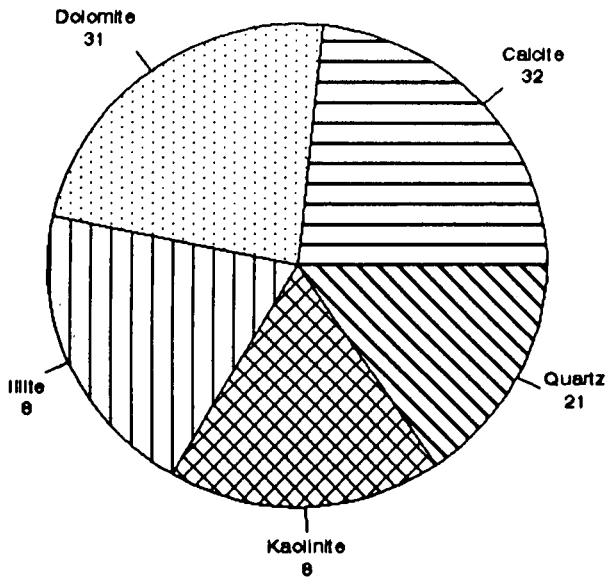
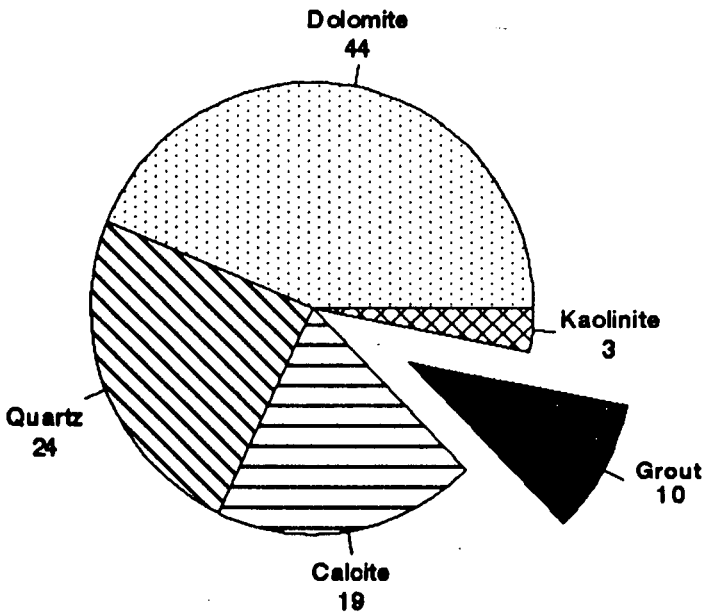
NATIVE MATERIAL FROM SCREEN AREA



PRE-PURGE GROUNDWATER SAMPLE

No Clay Recovered

SILT-TRAP SEDIMENT SAMPLE



POST-PURGE GROUNDWATER SAMPLE

No Clay Recovered

FIGURE 2. MINERALOGY OF SAMPLES FORM MONITORING WELL 3432 IN PERCENT

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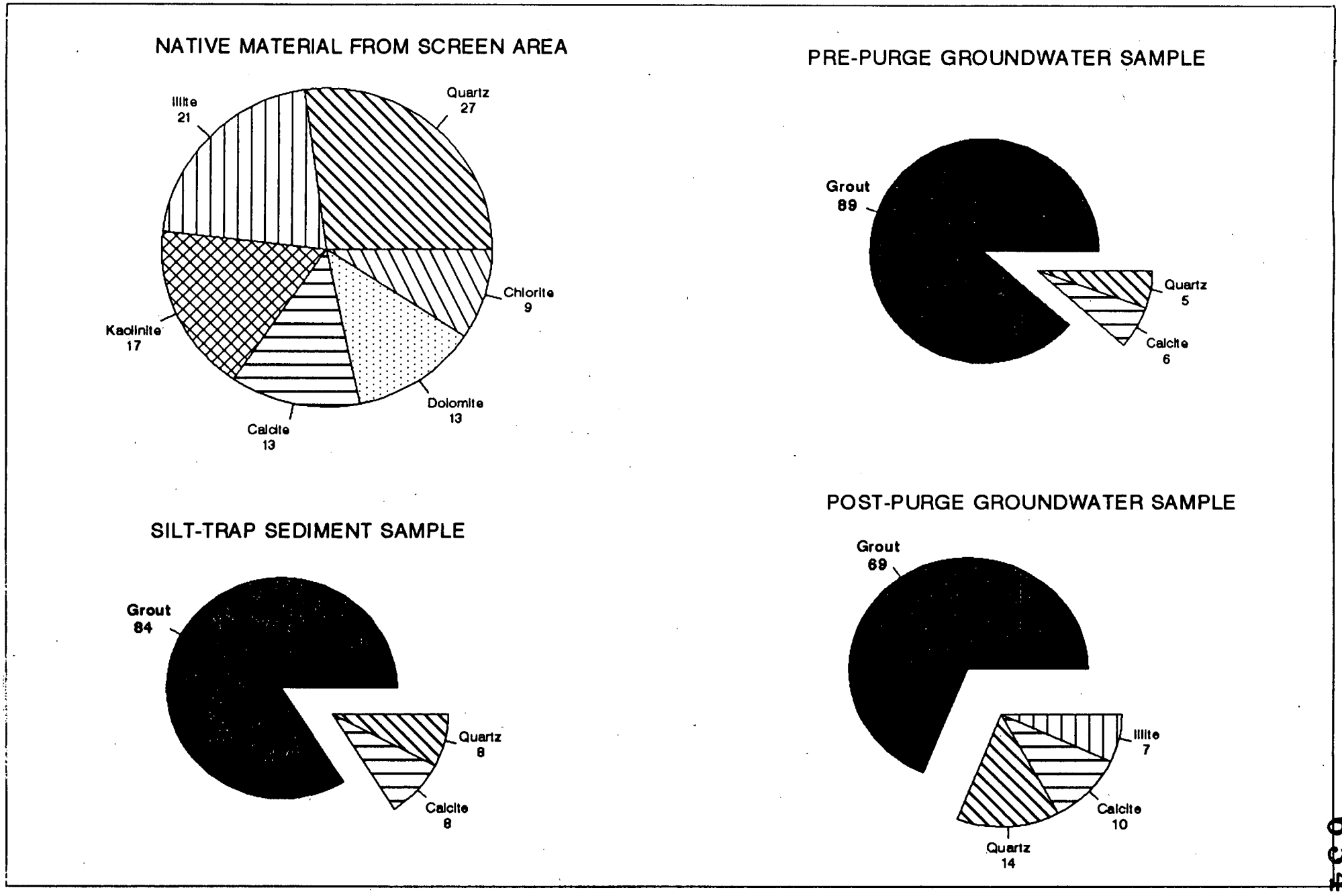

FIGURE 3. MINERALOGY OF SAMPLES FROM MONITORING WELL 41217 IN PERCENT

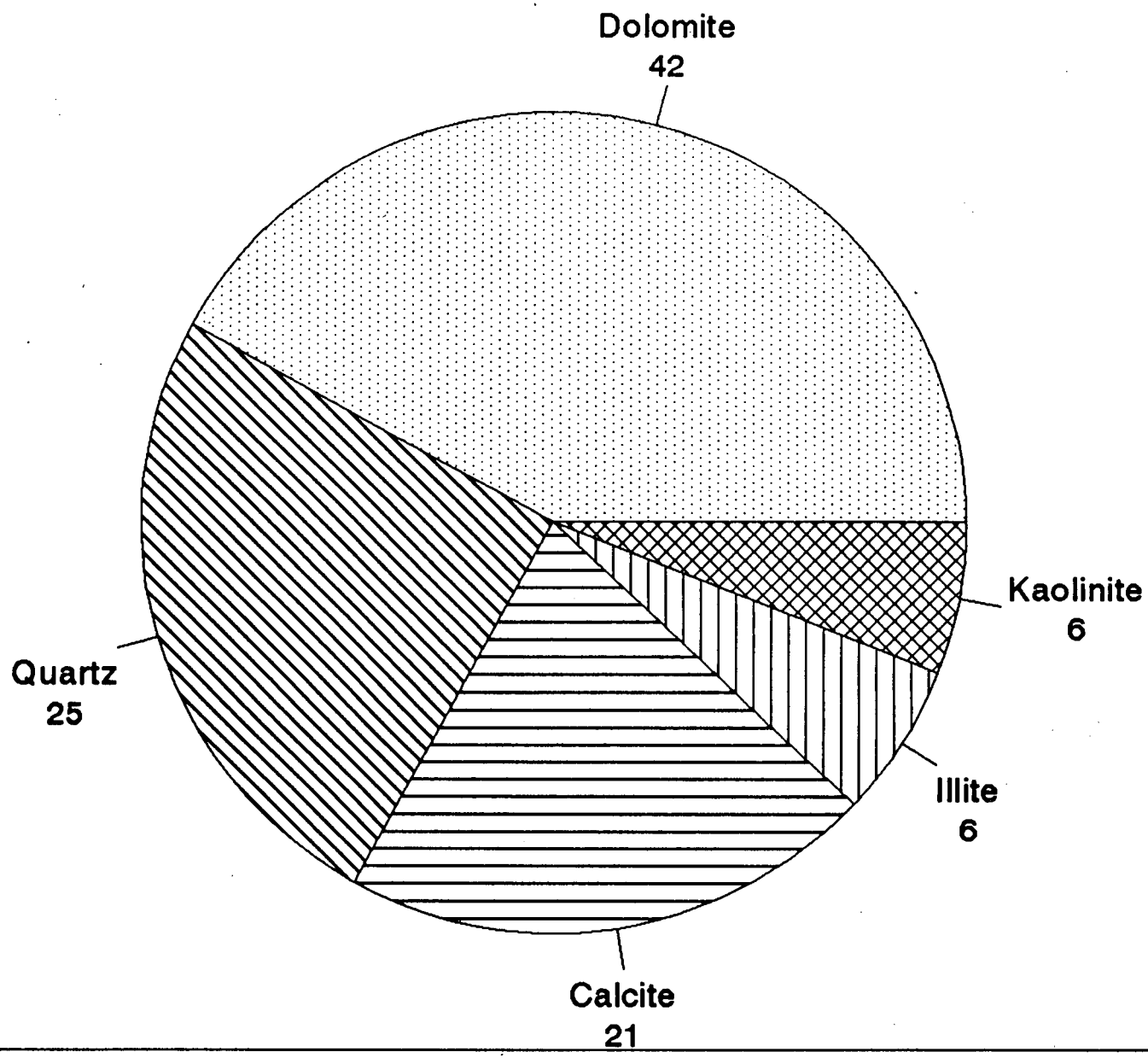

FIGURE 4. MINERALOGY OF SILT-TRAP SEDIMENTS FROM MONITORING WELL 2387 IN PERCENT

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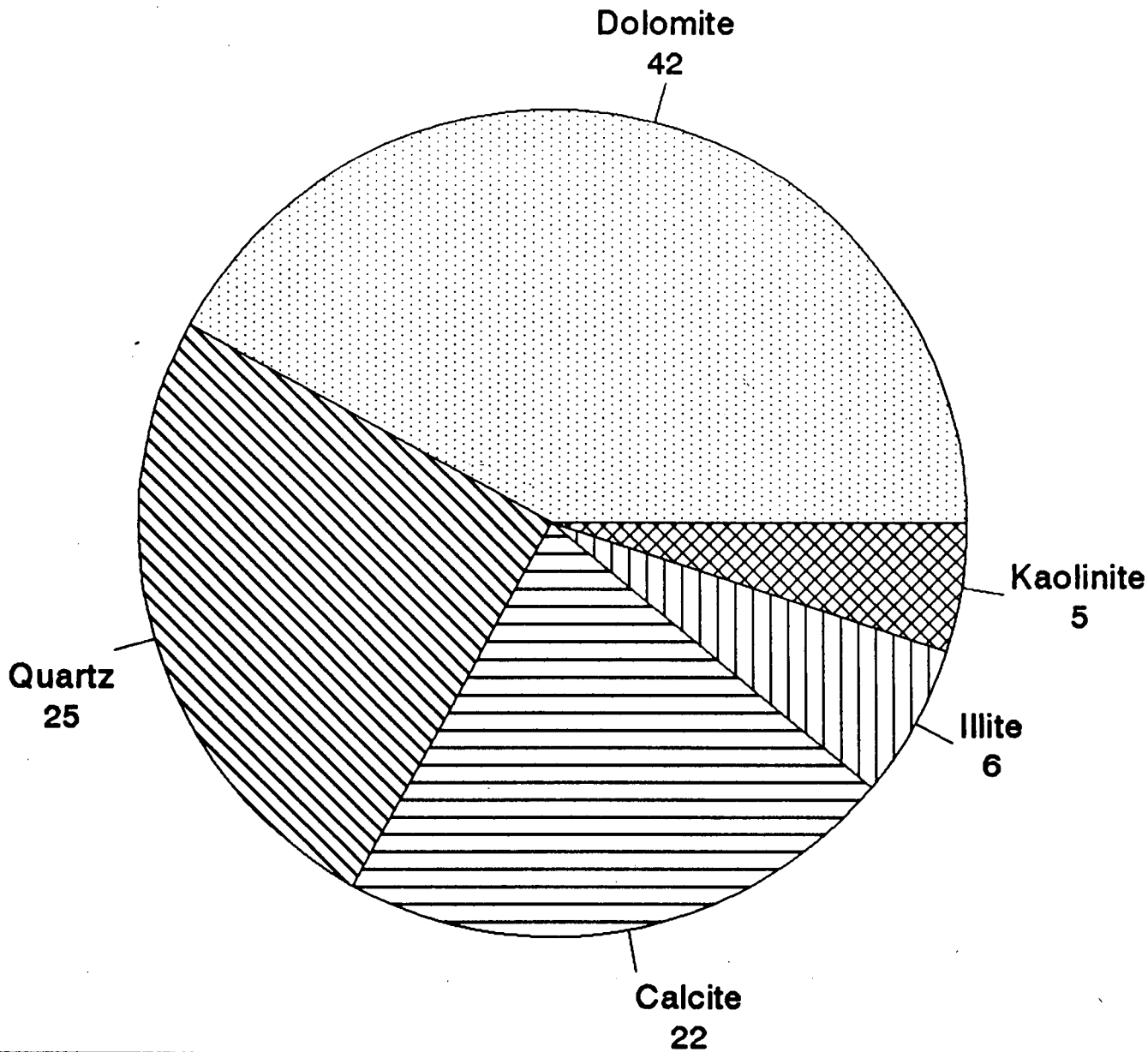

FIGURE 5. MINERALOGY OF SILT-TRAP SEDIMENTS FROM MONITORING WELL 2431 IN PERCENT

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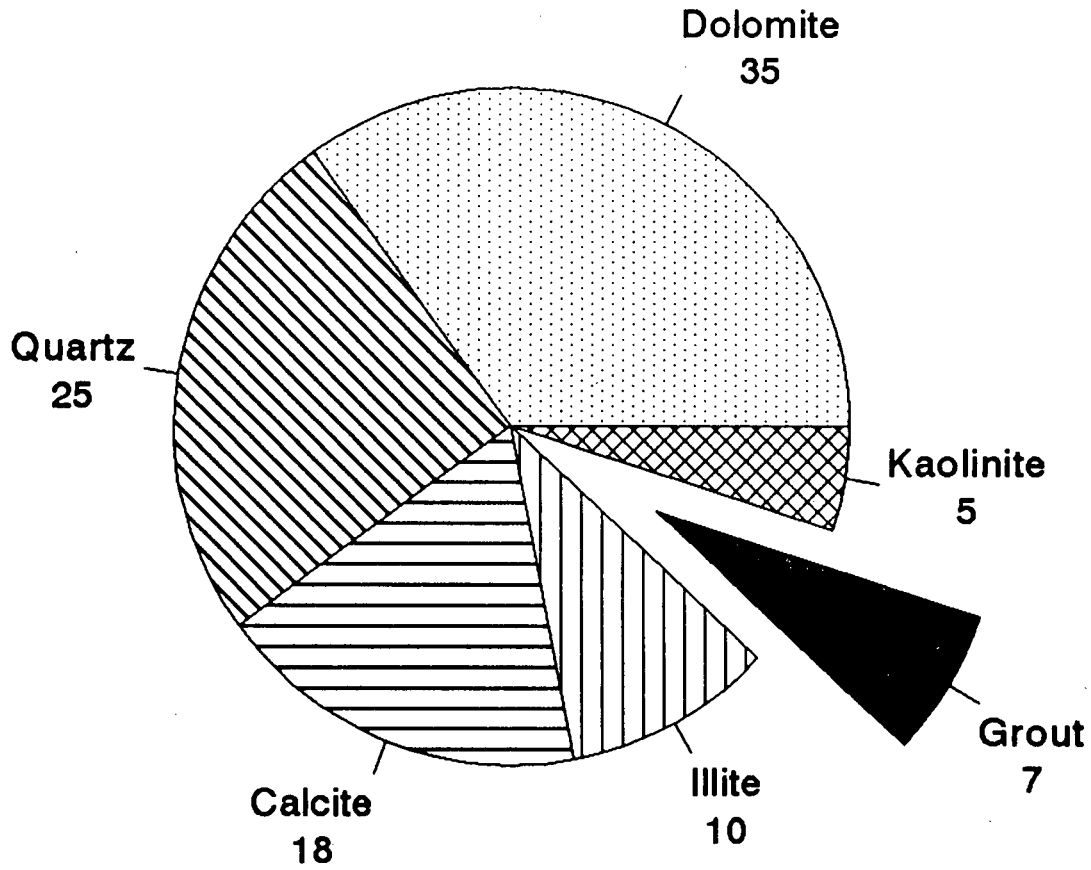

FIGURE 6. MINERALOGY OF SILT-TRAP SEDIMENTS FROM MONITORING WELL 2733 IN PERCENT

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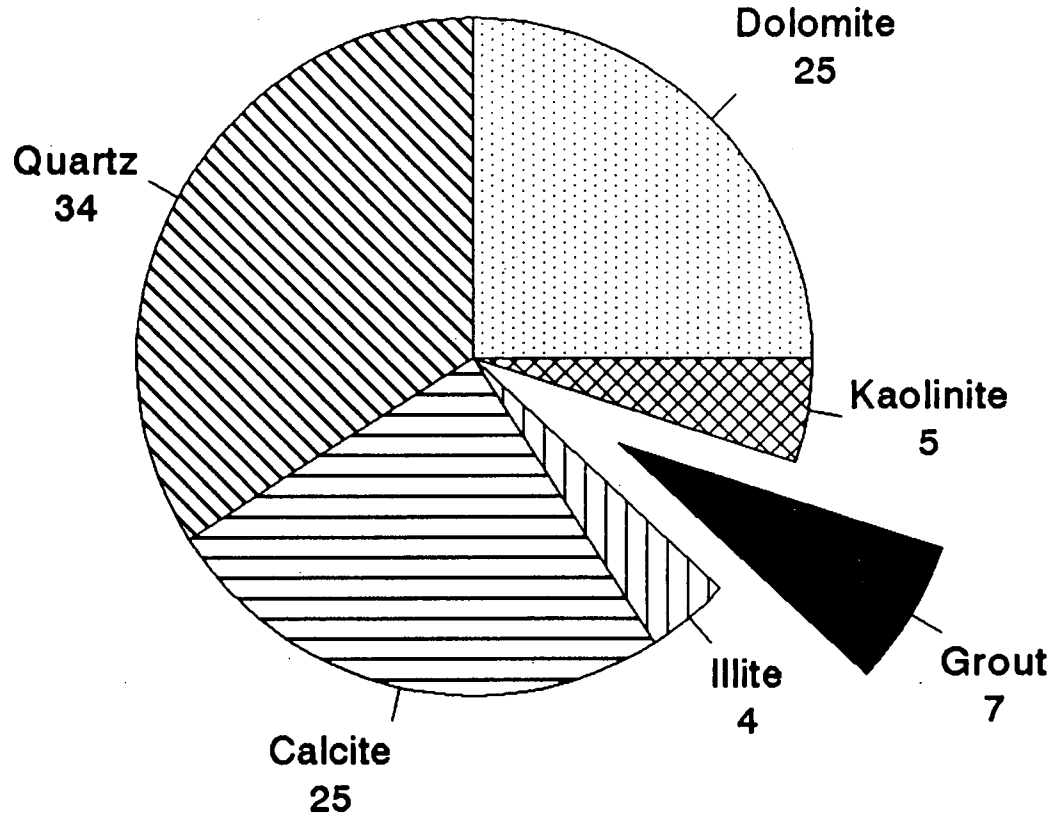

FIGURE 7. MINERALOGY OF SILT-TRAP SEDIMENTS FROM MONITORING WELL 3426 IN PERCENT

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ATTACHMENT II

TO: Cindy Tabor, FERMCO November 7, 1994
FROM: Rich Abitz, IT Corp
SUBJECT: Ion exchange/sorption of COCs on Na-montmorillonite grout

Wells containing suspended sediment with a component of sodium-montmorillonite grout are being investigated to determine if ion exchange and/or sorption of COCs is occurring on the grout. Sodium montmorillonite has a high cation exchange capacity (about 150 milliequivalents per 100 grams), and it will readily exchange Na for divalent cations available in GMA groundwater. The most abundant divalent cations in GMA groundwater are Ca and Mg, and these cations will have compete most strongly for the Na-montmorillonite exchange sites. Calcium has the highest affinity for the exchange site, as Ca-montmorillonites are the most common in nature (Deer et al., 1978). Other divalent cations that may be present in GMA groundwater include Be, Cd, Cu, Fe, Mn, Ni, Pb, Ra, Sr, and Zn. These cations may also exchange for sodium, but their affinity for exchange is many orders of magnitude lower than Ca and Mg. The lower affinity for these divalent cations is primarily due to their concentrations in GMA groundwater being three to six orders of magnitude lower than Ca and Mg. Therefore, significant exchange/adsorption of the COCs with Na in the grout is not expected to occur.

Sodium in the grout may also exchange for the monovalent cations in GMA groundwater. The most abundant (after Na itself) being K, with possible trace concentrations of Ag, Cs, and Tl. In general, the exchange affinity for monovalent cations is less than divalent cations (Deer et al., 1978), and the abundance of the divalent cations Ca and Mg in GMA groundwater makes it unlikely that significant monovalent exchange will occur.

Adsorption of neutral and negative aqueous complexes by Na-montmorillonite is not significant (probably less than 5 percent of adsorptive capacity). Therefore, a wide range of potential COCs that form neutral and negative complexes (e.g., $UO_2(CO_3)_3^{-4}$, $AgCl^{\circ}$, AsO_3F^{-2}, TcO_4^{-}, $Th(HPO_4)_3^{-2}$) will not be affected significantly by the presence of montmorillonite in the groundwater.

Reference

Deer, W.A., R.A. Howie, and J. Zussman, 1978, *An Introduction to the Rock Forming Minerals*, Longman Group Limited, London.