

**INACTIVE PRODUCTION ROCK SITES AND QUARRIES
2002 ANNUAL REPORT**

Kennecott Greens Creek Mining Company

August 2003

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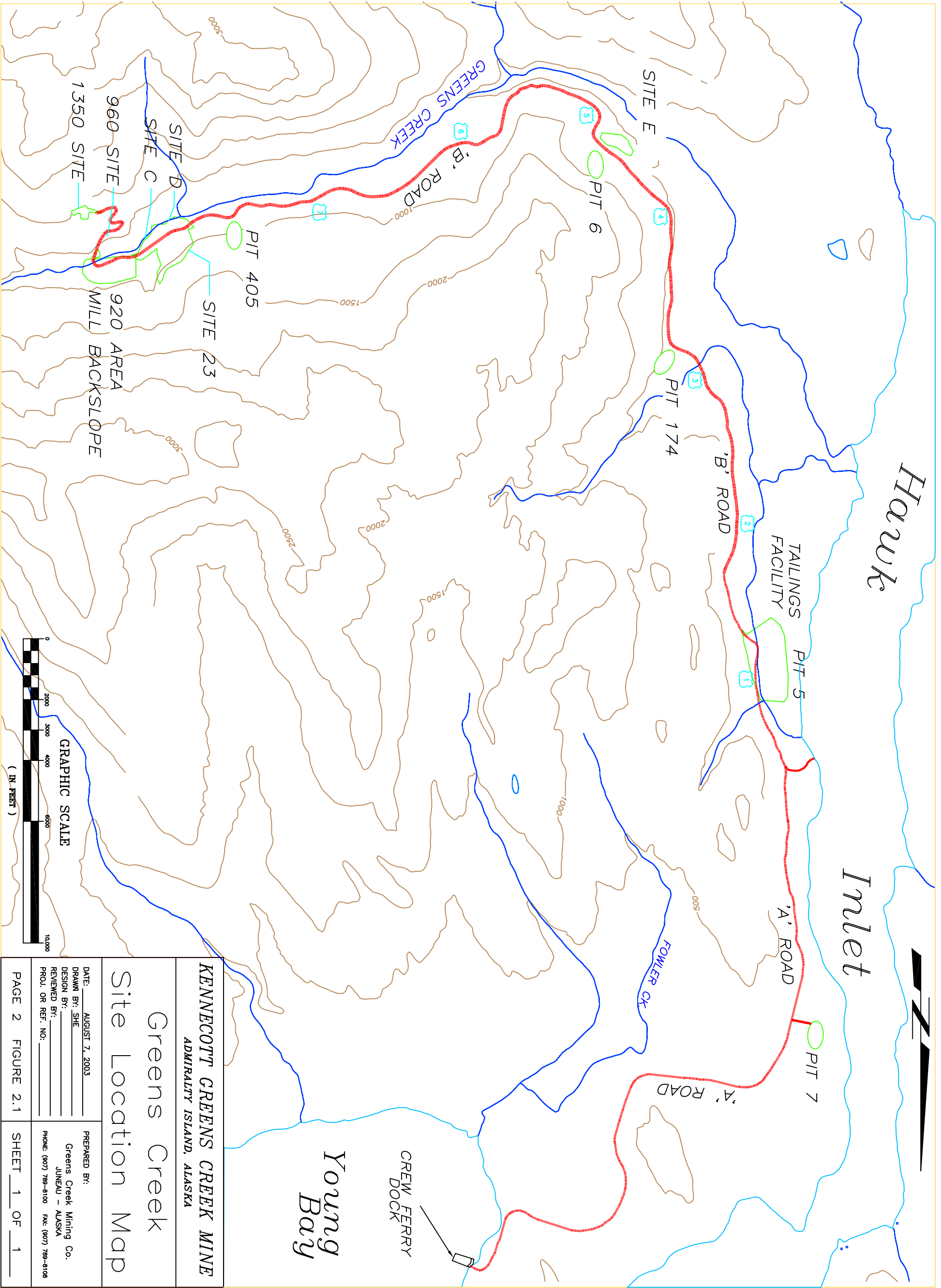
1.0 Executive Summary

This annual report has been prepared by Kennecott Greens Creek Mining Company in accordance with the mine's General Plan of Operations Appendix 11, Attachment C. Monitoring data summaries are presented for five inactive production rock sites (1350, 960, Mill Backslope, Site C and Site E) and five quarries (Pit 405, Pit 6, Pit 174, Pit 5 and Pit 7). Pit 5 is currently the only quarry where active rock excavation still occurs.

The report is separated such that all aspects of the inactive production rock sites are discussed first in Section 2 followed by discussion of the quarries in Section 3. Information that is pertinent to both sections is generally not repeated but is discussed in the most relevant section and identified by reference in the other section.

Acid base accounting results from grid samples collected at inactive production rock sites in 2002 support previous investigations. The sites contain a mixture of acid generating and acid neutralizing rock and except for the Mill Backslope the bulk of the material has near-neutral pH. The inactive sites have drainage dominated by near-neutral waters having sulfate and metals concentrations consistent with exposed production rock. Less than 10 percent of the grid samples had pH values less than 6.0, indicating that the vast majority of samples continue to have sufficient buffering capacity to prevent acidic drainage in the near term. Base flows at inactive site sample locations are low (generally less than 1gpm), and no significant influence on sensitive receiving areas has been identified.

The exposures in the rock quarries generally contain far less pyrite and carbonate than is contained in production rock. Two of the five quarries (Pit 405 and Pit 174) have zones of potentially acid generating rock that are of significance, however the volume of runoff from these zones is small. Lower sulfide contents and smaller surface areas yield a lower flux of oxidation products from quarries compared to production rock sites. Water monitoring indicates that metal loading from pit walls is also lower than loading from production rock sites. Metal loading identified in the drainage from Pit 5 does not appear to be solely associated with the pit walls and may reflect influences from the water treatment plant and the tailing facility.



KENNECOTT GREENS CREEK MINE ADMIRALTY ISLAND, ALASKA	
Greens Creek	
Site Location Map	
DATE: AUGUST 7, 2003 DRAWN BY: SHE DESIGN BY: REVIEWED BY: PROJ. OR REF. NO.:	PREPARED BY: Greens Creek Mining Co. JUNEAU - ALASKA PHONE: (907) 789-8100 FAX: (907) 789-8108
PAGE 2 FIGURE 2.1	SHEET 1 OF 1

2.0 Inactive Production Rock Sites

2.1 Introduction

Kennecott Greens Creek Mining Company (KGCMC) has prepared this section of the Annual Report in accordance with the mine's General Plan of Operations (Appendix 11, Attachment C). A summary of all operational and monitoring activities performed at inactive production rock sites in 2002 is provided. Site locations are shown on Figure 2.1. Refer to GPO Appendix 11 for a detailed description of the facilities and associated monitoring requirements. Aspects of the inactive Site D are covered in the Tailings and Production Rock Site 2002 Annual Report (KGCMC, 2003), which also covers the active production rock site (Site 23) and tailings facility.

Surface sampling entailed collecting material from a grid that randomly produced the specified number of samples. Small sites were sampled by taking material from roughly equidistant locations along a transect across the site. The sampling was intended to minimize bias toward any one material type.

Summary statistics for KGCMC's inactive production rock sites are presented in Table 2.1. Acid Base Accounting Data are summarized in Figures 2.2 and 2.3. Water quality data are summarized in Figures 2.4 to 2.16. The sites are discussed individually in the subsequent sections. Refer to Figure 2.1 for site locations. The results of grid sampling and water monitoring in 2002 are consistent with previous investigations (KGCMC 1994, Shepherd Miller 2000, ADEC, 2003). These investigations concluded that some of the material is potentially acid generating but that the vast majority of the material maintains a pH greater than 6.0 and that sensitive receiving areas continue to be adequately protected. This annual report serves as a follow-up to these previous investigations and generally does not repeat data and information presented in these reports, unless doing so provides continuity and clarity.

Table 2.1 2002 Summary Statistics for Inactive Production Rock Sites

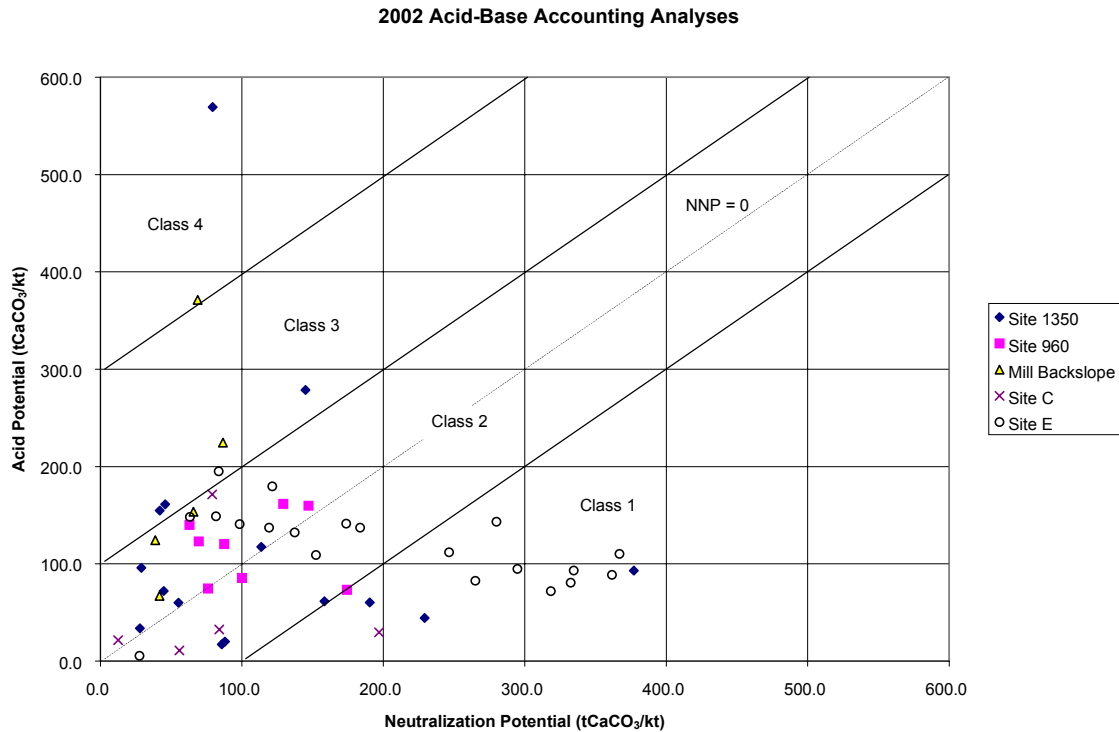
	Inactive Sites				
	1350	960	Mill Slope	Site C	Site E
Years Active (approx.)	1978-1985	1987-1988	1987-1988	1987-1988	1988-1994
Acreage	5	1	20	2	9
Total Volume (yds)	40,000	9,000	ND	50,000	365,000
Prod Rock Vol (yds)	40,000	9,000	ND	ND	ND
Reclamation Material (yds)	0	0	0	0	10,000
Average NP (tCaCO ₃ /kt)	114	106	60	58	202
Average AP (tCaCO ₃ /kt)	123	117	188	59	118
Average NNP (tCaCO ₃ /kt)	-9	-12	-128	-1	85
Average Rinse pH	7.4	7.6	4.9	7.4	7.4

ND (not determined)

Figure 2.2 compares Acid Potential (AP) with Neutralization Potential (NP) from surface grid samples. The inactive sites were constructed prior to development of the classification protocol that KGCMC currently uses. At the time the inactive piles were constructed KGCMC did not classify or segregate its production rock. Symbols in Figure 2.2 represent actual laboratory data points. Lines indicating the currently utilized production rock classes are shown on Figure 2.2 for

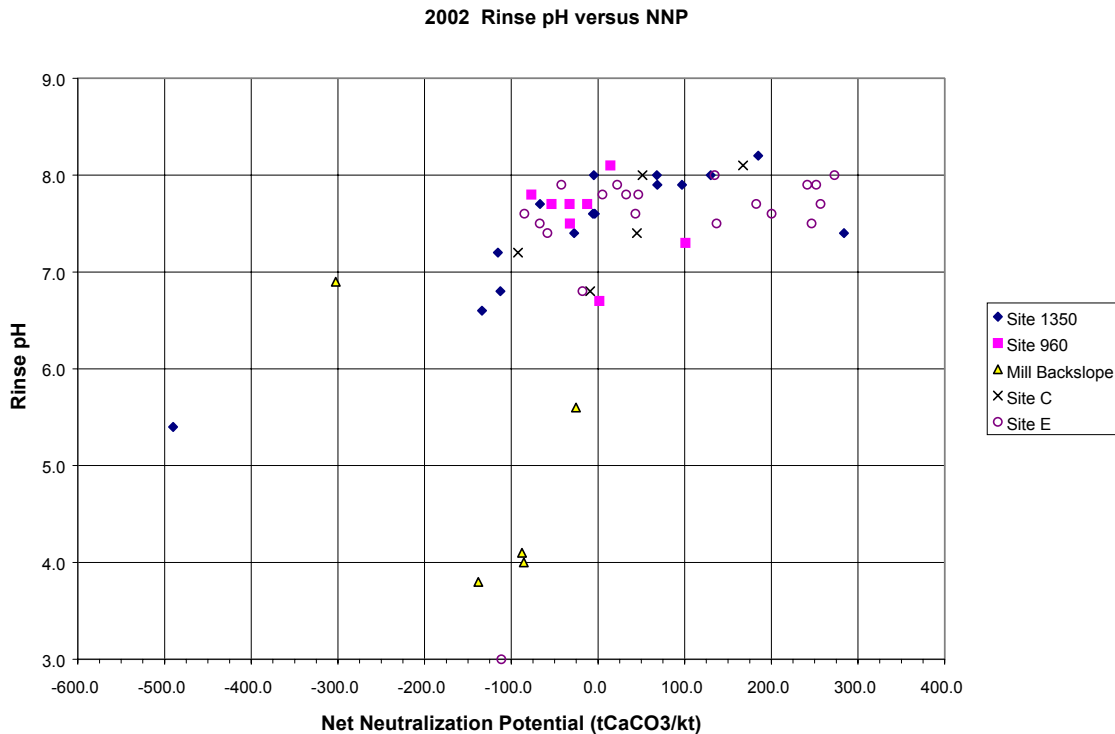
reference only. Figure 2.2 shows a wide distribution of potentially acid generating (upper left half of figure) and potentially acid neutralizing (lower left half of figure) samples. Most of the samples would be classified as Class 2 under the current classification procedure. Regardless of pyrite content, almost all production rock at Greens Creek contains substantial carbonate (5 to 40 %). Although approximately half of the grid samples are potentially acid generating, their carbonate contents indicate that there is a relatively long lag time to potential acid generation for the majority of the samples.

Figure 2.2 2002 Inactive Production Rock Site Acid Base Accounting Analyses



A long lag time to potential acid generation explains why only a few samples show signs of acidification and indicates sufficient time remains available to reclaim the sites, pending availability of backfill space underground or cover material. Figure 2.3 shows the relationship between surface rock grid sample rinse pH and net neutralization potential (NNP). NNP is the balance between NP and AP. A negative NNP typically indicates the sample is potentially acid generating. Rinse pH is a measure of the pH of a one-to-one mixture of “as-received” fines and water. Rinse pH is different than paste pH, which is the pH of the sample after it has been pulverized and moistened. Rinse pH is often lower than paste pH because pulverizing the sample exposes fresh, sometimes alkaline, mineral surfaces. The rinse pH method also uses more water, which can dissolve surface oxidation products, lowering the pH of the solution. The rinse pH data in Figure 2.3 demonstrate that the vast majority of the samples retain enough buffering capacity to maintain pHs above 6.5. Six of the more than 50 samples show evidence of buffering capacity depletion. These six samples are generally very pyritic and lack significant carbonate mineralization. Four of these six samples are from a bench of pyritic rock on the Mill Backslope.

Figure 2.3 2002 Inactive Production Rock Site Rinse pH Data



Flow data presented in Figure 2.4 demonstrate that flows at most of the sample locations are generally low (less than 1 gpm). Much of the flow data were collected as part of the NPDES stormwater monitoring program. Collected during or following storm events, flow data from these locations (e.g. Site E 356, 960 347) represent short-term maximum flow values. Lack of significant flow from inactive sites is a positive characteristic because it reflects minimization of potential off-site impacts.

Figure 2.5 shows pH data from inactive site sampling locations. Lower alkalinity values can represent influences from pyrite oxidation and/or organic acids from muskeg and forest soils. The data show that the vast majority of the site drainage remains above pH 6.0. The sample from the mill backslope in 1995 was runoff collected from a bench containing zones of heavily pyritized rock. For a brief period in 1998 and 1999, acidic conditions developed at Site 960 347. KGCMC applied lime and removed 1000 cubic yards of oxidized pyritic rock from the site in 2000. The pH of the drainage quickly rebounded and has remained near-neutral since 2000. Alkalinity data presented in Figure 2.6 are consistent with the pH results in Figures 2.3 and 2.5. Except for the one of the mill backslope sites, all sample locations maintain measurable alkalinity provided by dissolution of carbonate minerals.

Figure 2.4 Inactive Production Rock Site Flow Data

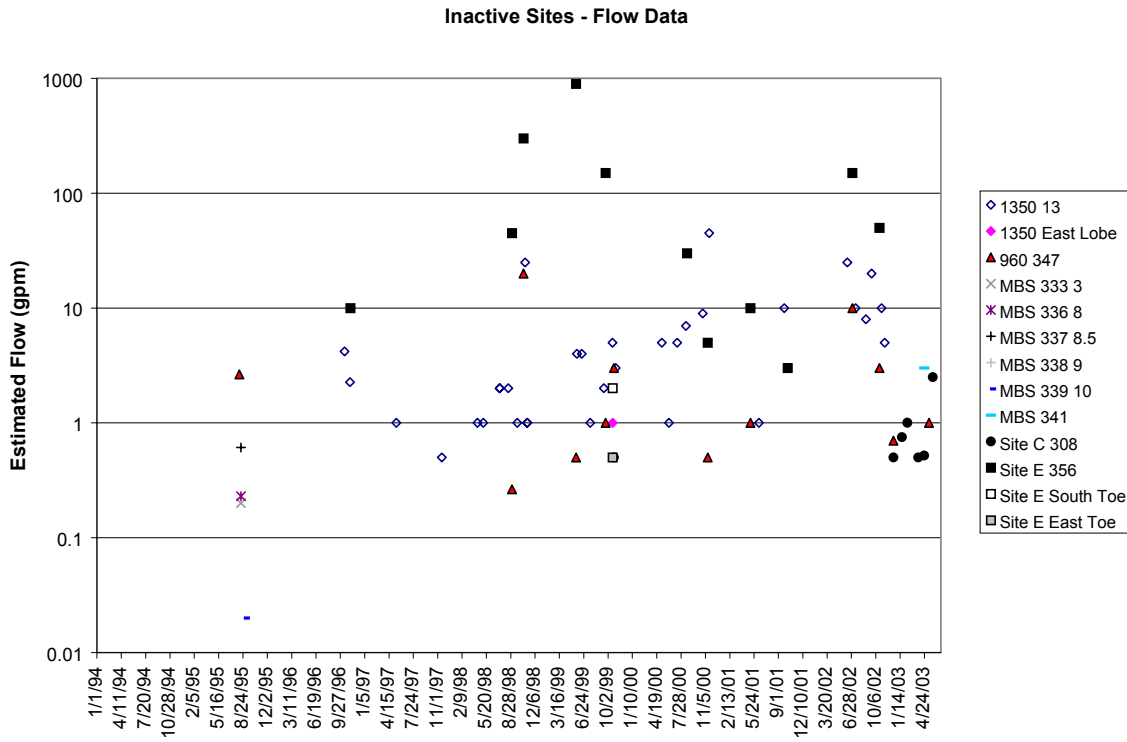


Figure 2.5 Inactive Production Rock Site pH Data

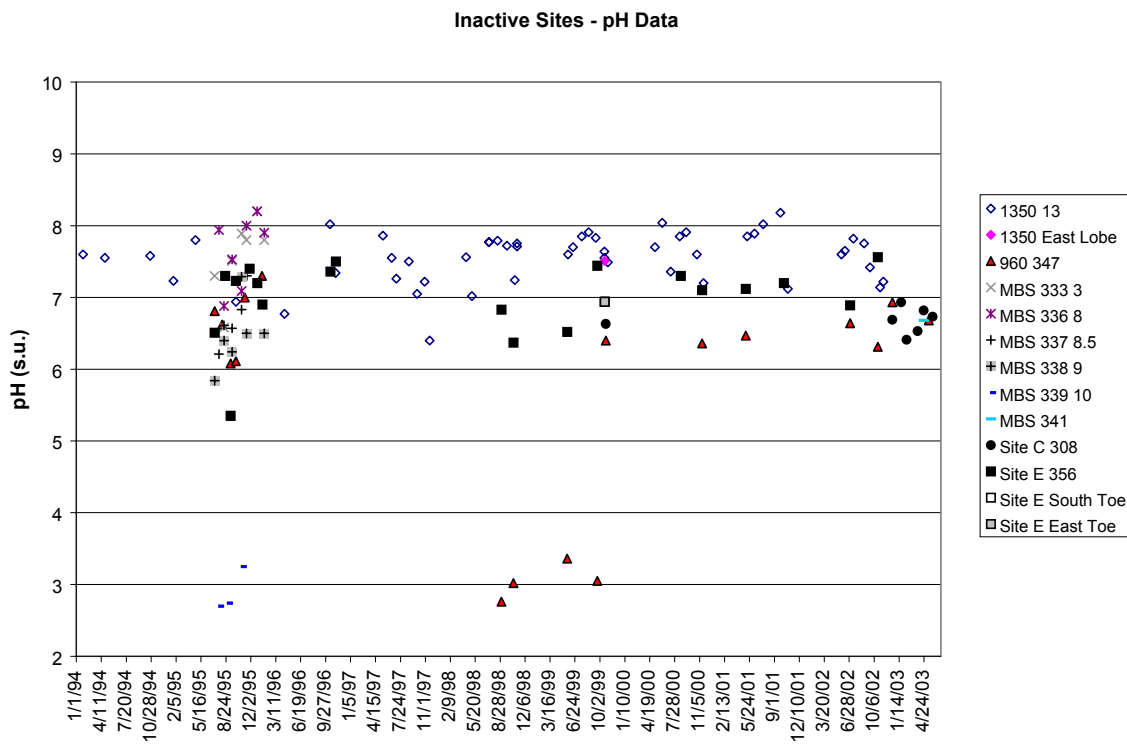
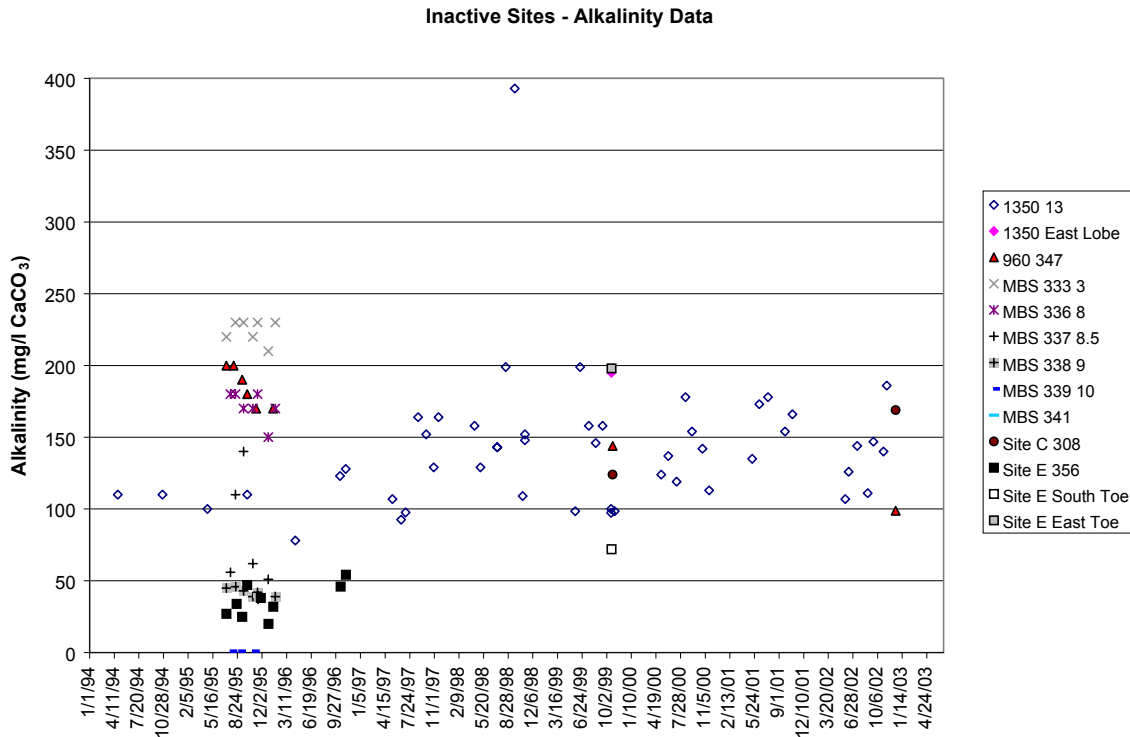


Figure 2.6 Inactive Production Rock Site Alkalinity Data



Conductivity data are shown in Figure 2.7. Conductivity indicates the amount of dissolved constituents in the water. KGCMC samples having higher conductivity values usually have higher sulfate, calcium and magnesium (hardness) concentrations, reflecting influences from sulfide oxidation and carbonate mineral dissolution. Water that has contacted production rock is expected to have higher conductivity values than background waters. Site E 356 and 960 347 show an overall decreasing trend in conductivity, and the 1350, Mill Backslope and Site C remain unchanged. The trends apparent in Figure 2.7 are the result of decreasing reactive surface area available for oxidation and dissolution. The reactive surface area decreases as reactants are consumed and mineral surfaces become coated with oxidation products. The results for sulfate, magnesium and hardness, shown in Figures 2.8, 2.9 and 2.10, respectively, correlate with conductivity results and are consistent with the concept of generally decreasing or static reactive surface area discussed above.

The data for zinc, copper, lead, cadmium, nickel and arsenic are presented in Figures 2.11 to 2.16. Sample results that were less than the detection limit are plotted at one half the limit value. While this allows the results to be plotted on a logarithmic scale, it causes non detect results with high detection levels to appear more concentrated than they actually are. Detection limits have varied with time and are often evident on the graphs as horizontal groupings of symbols. The results for metals generally correlate with conductivity values. Zinc concentrations reflect the higher solubility of this element relative to the others. Metal loads from inactive sites have either remained relatively constant or decreased with time. The decrease in metal loading is attributed to the reduction or reactive surface area discussed above.

Figure 2.7 Inactive Production Rock Site Conductivity Data

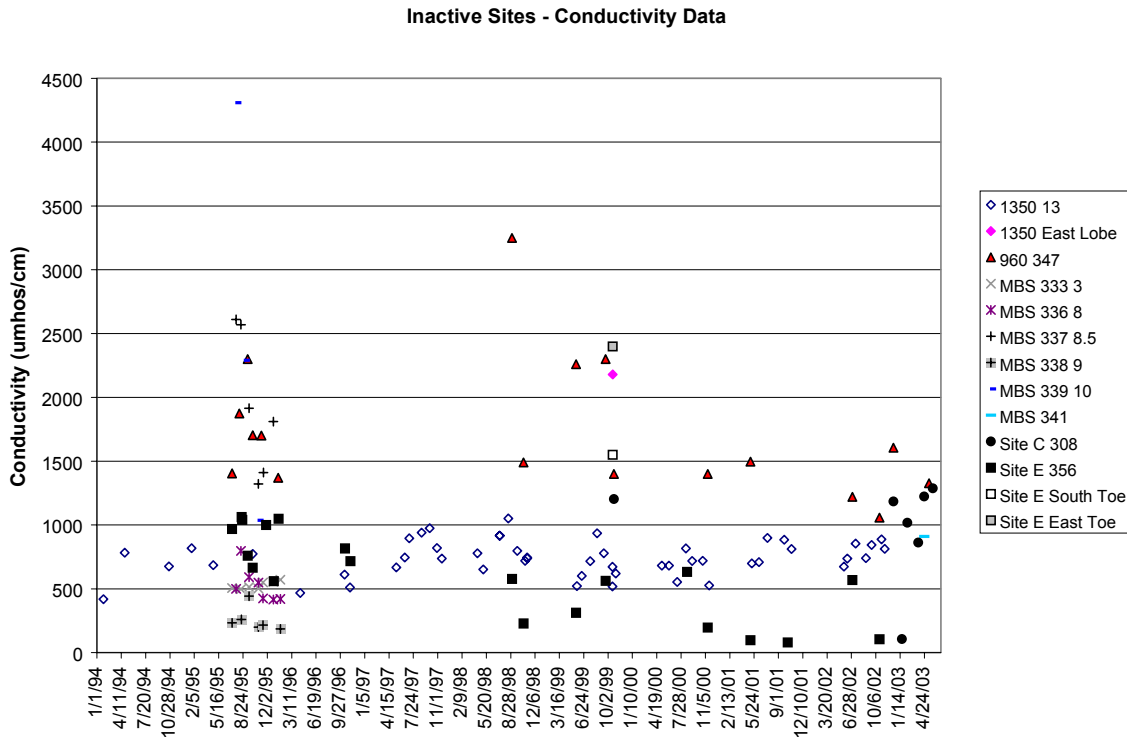


Figure 2.8 Inactive Site Production Rock Site Sulfate Data

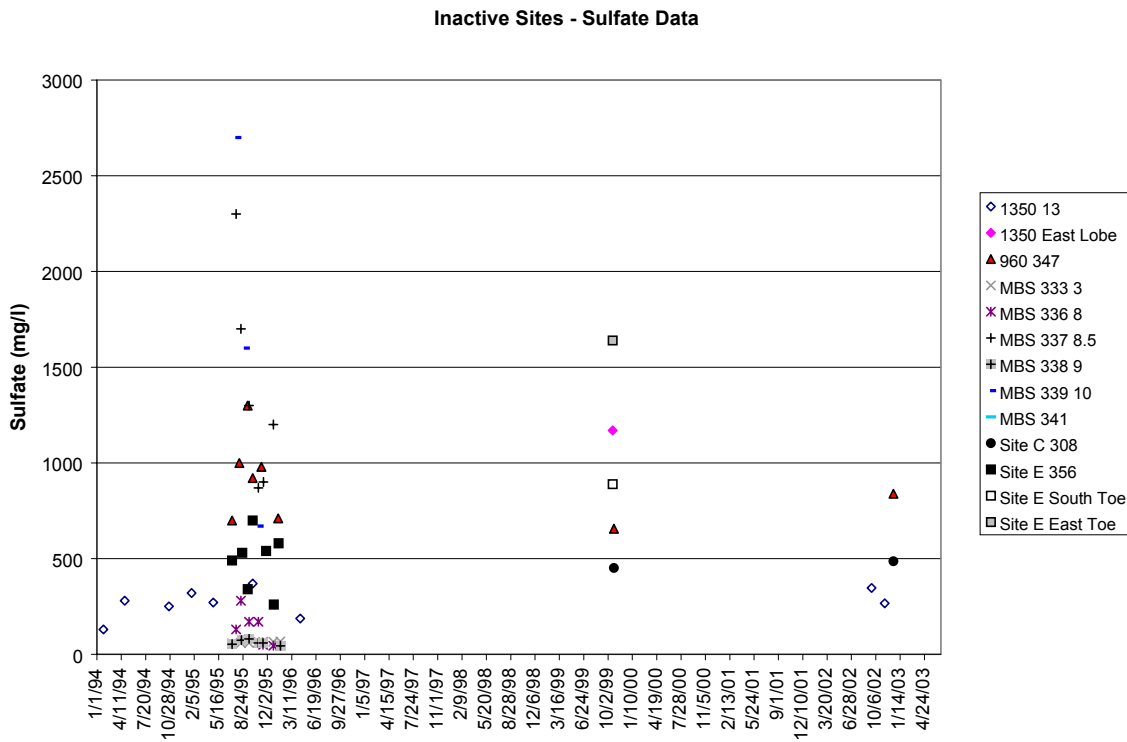


Figure 2.9 Inactive Production Rock Site Magnesium Data

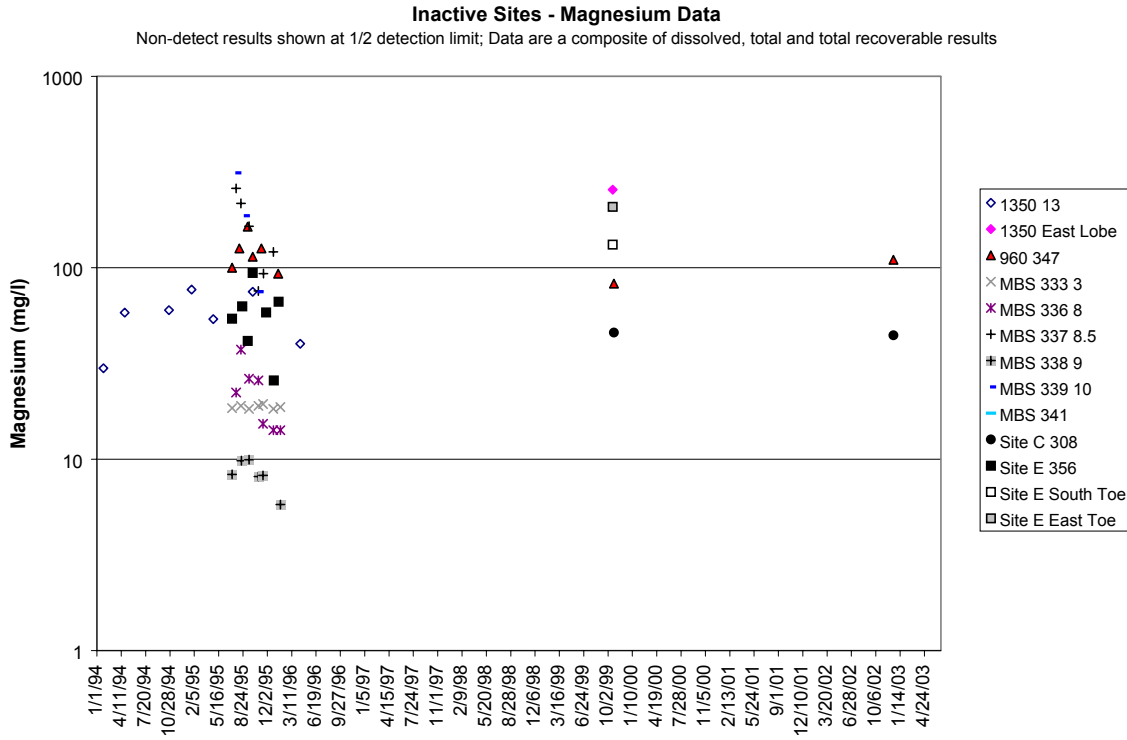


Figure 2.10 Inactive Production Rock Site Hardness Data

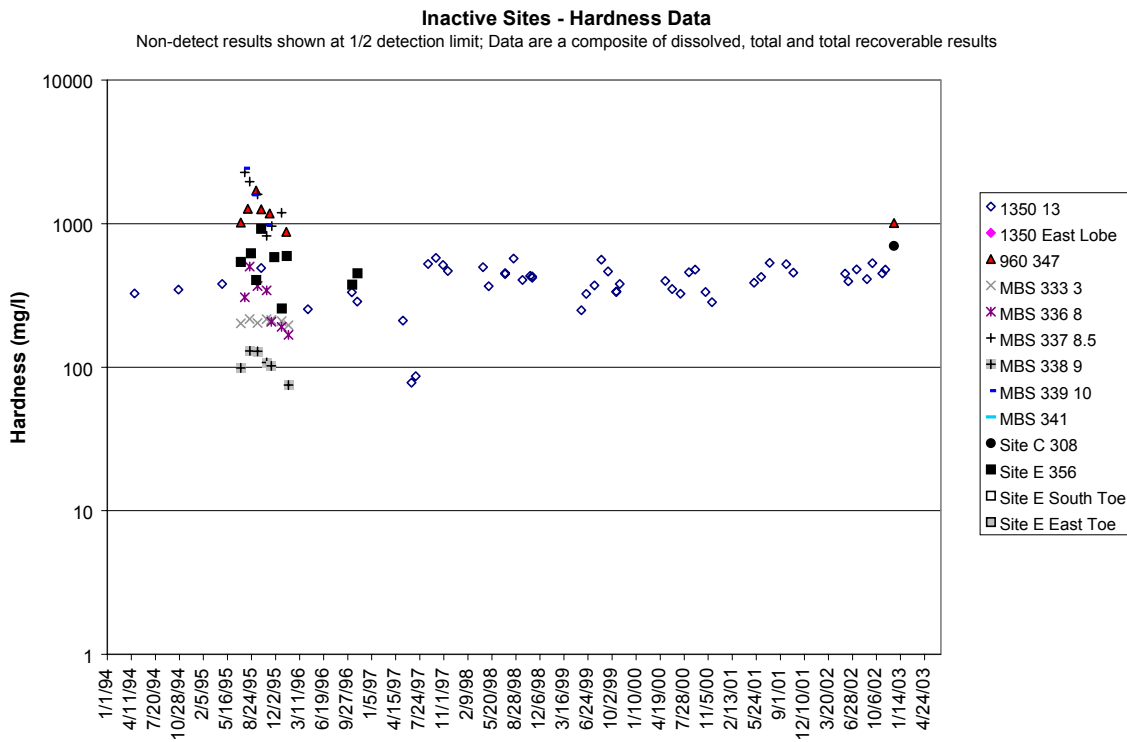


Figure 2.11 Inactive Production Rock Site Zinc Data

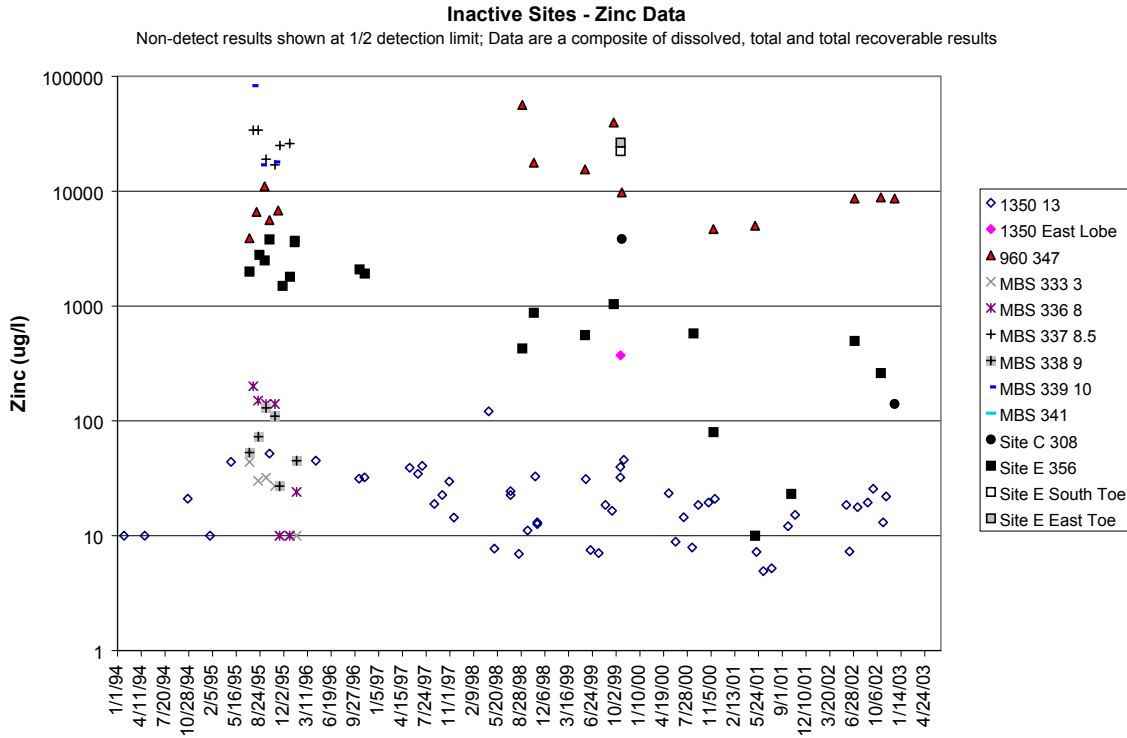


Figure 2.12 Inactive Production Rock Site Copper Data

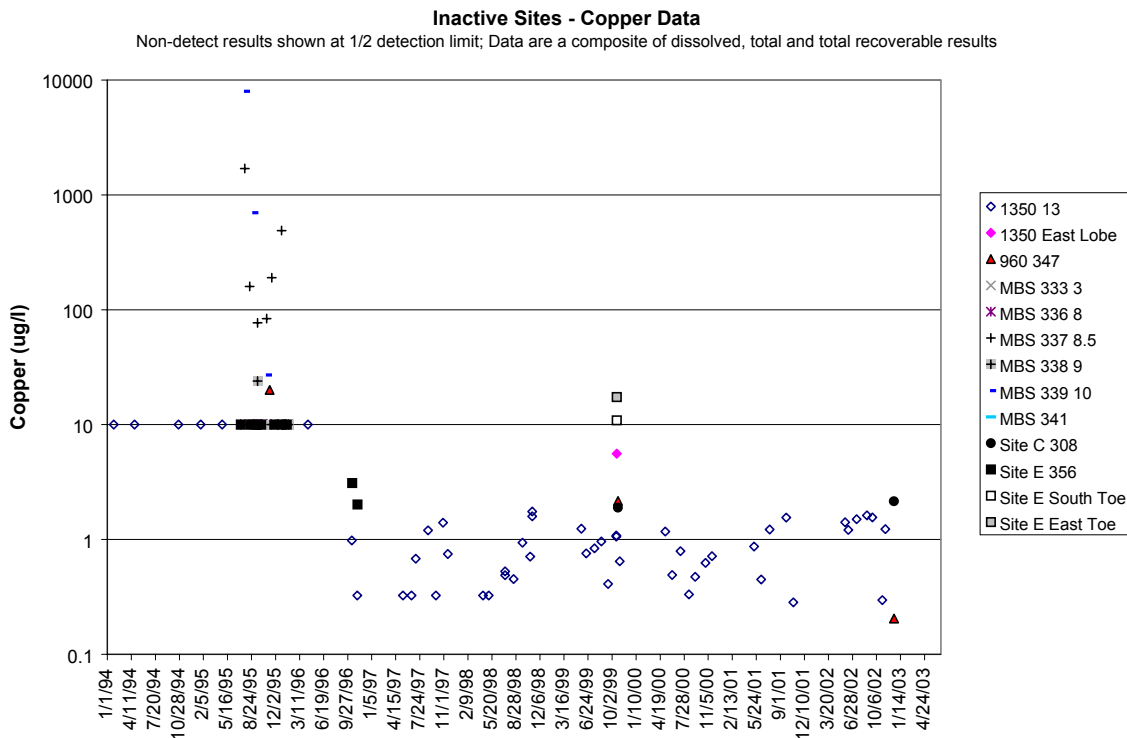


Figure 2.13 Inactive Production Rock Site Lead Data

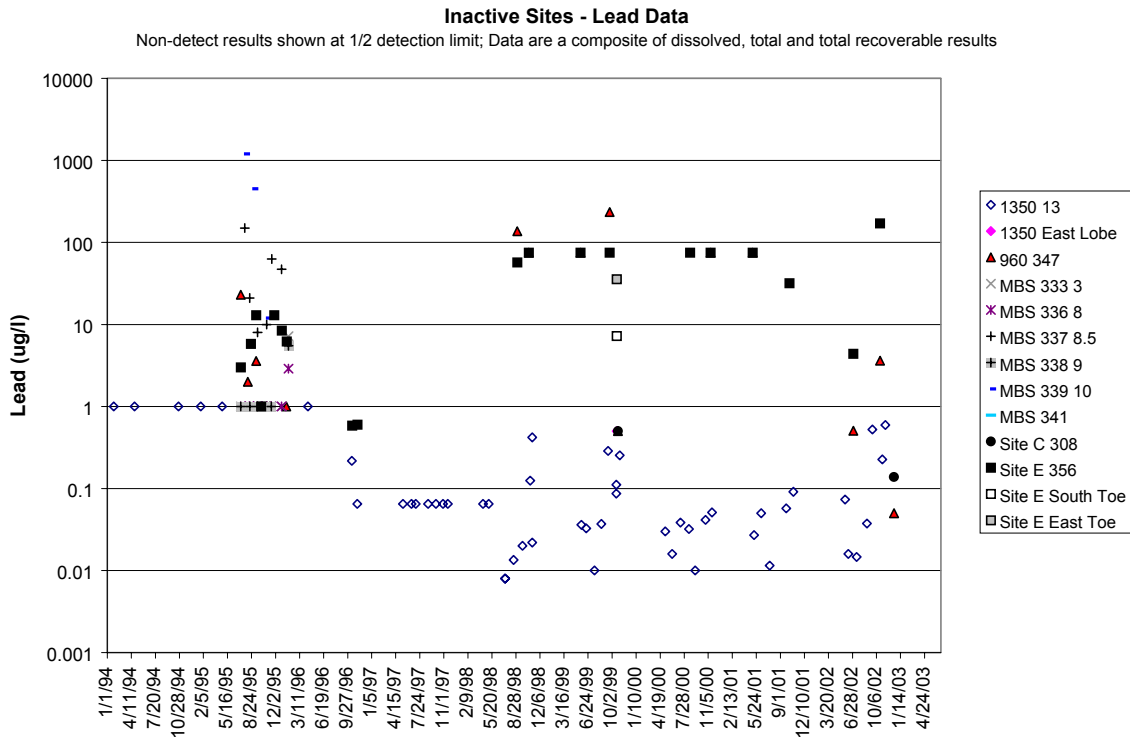


Figure 2.14 Inactive Production Rock Site Cadmium Data

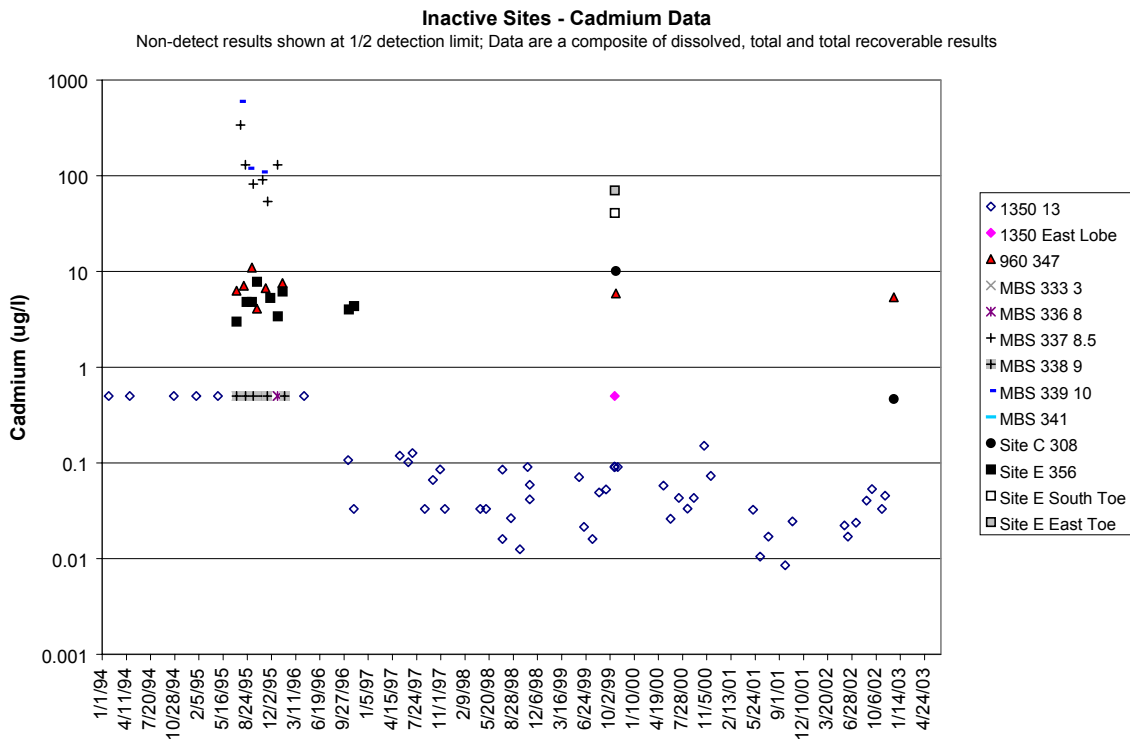


Figure 2.15 Inactive Production Rock Site Nickel Data

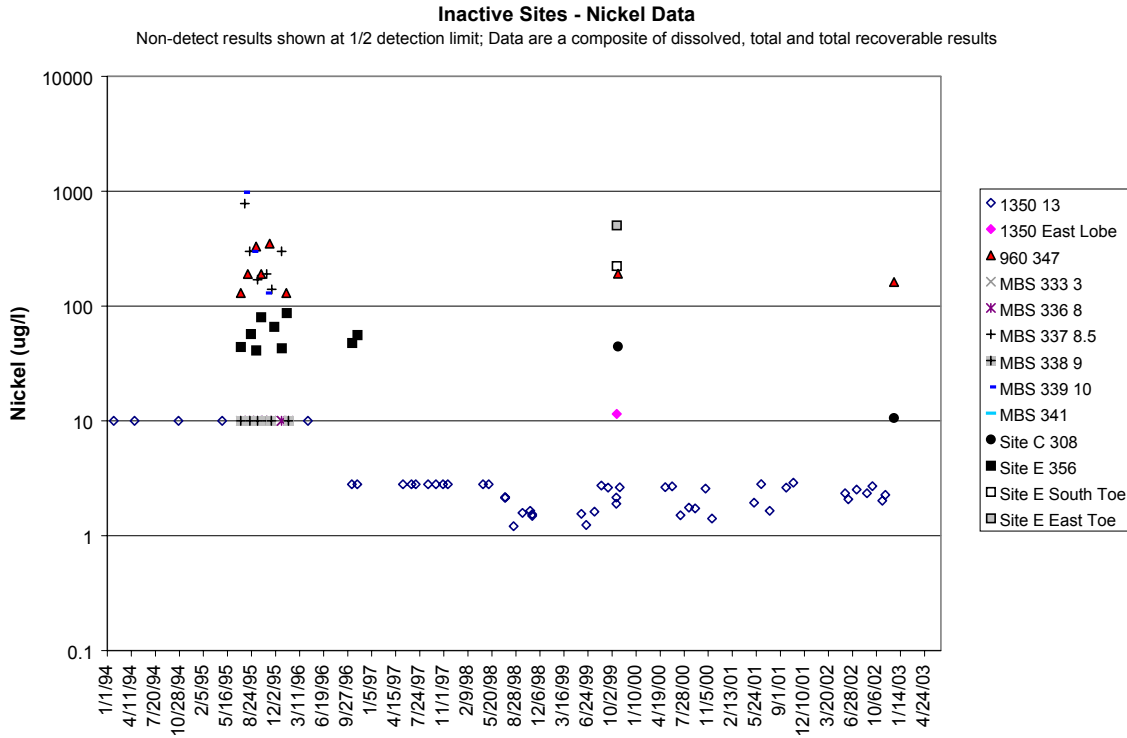
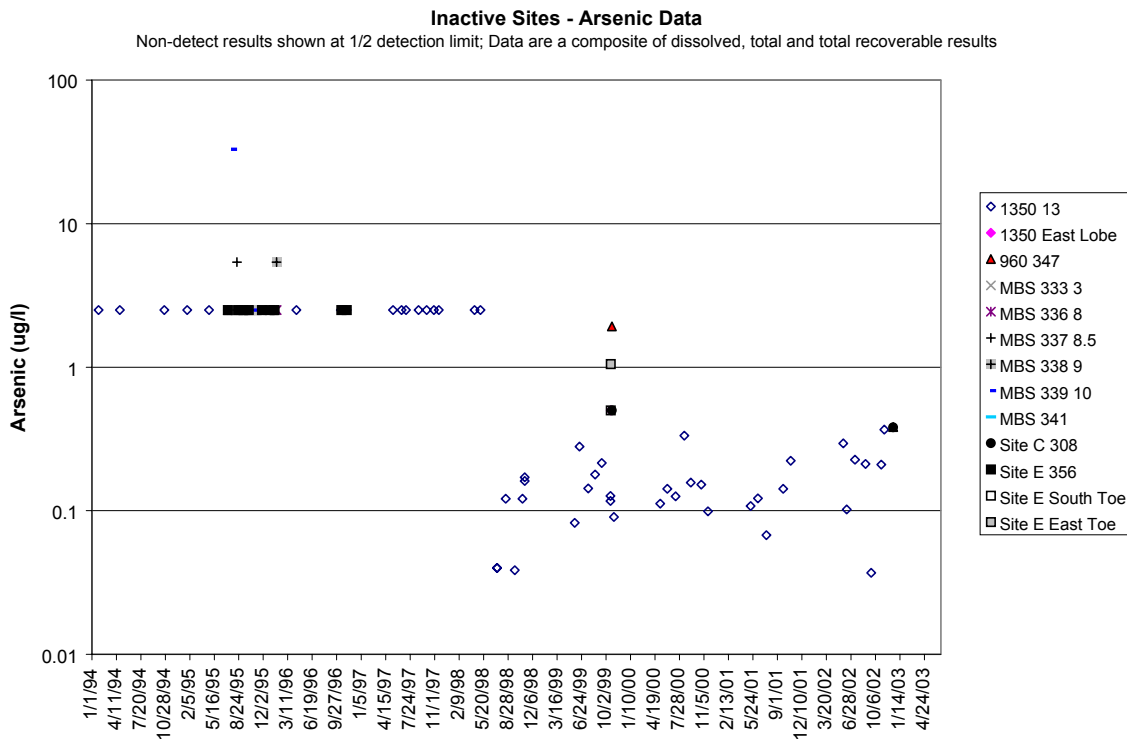


Figure 2.16 Inactive Production Rock Arsenic Data



2.2 1350 Site

The 1350 Site is located at the 1350' level above the main portal and concentrator facility (Figure 2.1). The site contains approximately 40,000 cubic yards of material derived from advancement of the 1350 portal, which began in 1978 and continued intermittently through 1985. Flow from the site is low and the drainage remains near-neutral. Other characteristics of the drainage (Figures 2.8 to 2.16) include a moderate sulfate load, generally low metal concentrations, and localized iron staining. The results of grid sampling in 2002 (Figures 2.2 and 2.3) demonstrate that although some of the rock is potentially acid generating, the majority of the material remains near-neutral. Small areas containing rock with the greatest pyrite content have produced acidic oxidation products, but they are limited in extent and do not have a significant effect on the pile drainage. Monitoring in Greens Creek, below the confluence with the 1350 drainage indicates no significant effects from this site.

Steep slopes preclude constructing an oxygen-limiting soil cover on the site in its current configuration. Consequently, KGCMC intends to remove the production rock from the site. Hauling the rock back into the mine via the 1350 portal is a feasible alternative, however ventilation and access infrastructure prevent doing so prior to closure of the underground workings. Other more logistically complex alternatives include hauling the material down to the 920 portal or one of the active surface disposal facilities. KGCMC will continue to monitor the site and will select an appropriate removal alternative that best suits the site's weathering performance and underground accessibility.

2.3 960 Site

The 960 Site is located just above the 920 Portal on the road to the 1350' level. Approximately 10,000 cubic yards of production rock were placed at the site in 1987 and 1988 during development of the 920 Portal and access road to the 1350 level. Placement was terminated when signs of slope instability developed below the site. Approximately 1000 cubic yards of rock were removed from the site and placed at Site23 or underground as backfill in 2000.

Grid sampling and water monitoring data are consistent with those of earlier reports (KGCMC 1994 and Shepherd Miller 2000) indicating that some of the rock is potentially acid generating. Intermittent periods of acidification have occurred, although the drainage from the site is currently near-neutral. KGCMC applied lime to the site while material was being removed in 2000. Higher metal concentrations (e.g. zinc, Figure 2.11) are attributed to influences from localized accumulations of acidic oxidation products. The 960 site is relatively small in extent (1 acre) and drainage flows are low (typically well below 5 gpm). Monitoring in Greens Creek below the 960 Site shows no signs of significant effects from this site or other up-gradient sites.

Removal of production rock to underground workings remains the preferred alternative for reclaiming this site. Opportunities for backfilling underground have been limited to date, but recent development of long hole stopes is expected to provide greater backfill opportunity in the near future.

2.4 Mill Backslope

A bench was cut into the valley floor at the 920 elevation providing level ground to facilitate construction of the mill/concentrator facility in 1987. Glacial till excavated from the site was hauled to Site D and Site E. Following excavation of the site and construction of the mill and related facilities, tension cracks developed above the excavated slope. Approximately 100

dewatering drains were drilled into the slope to lower the water table and reduce pore pressures. Two benches of production rock were placed on the lower half of the bank to buttress the slope and protect the drain manifold system.

Grid sampling of the Mill Backslope (Figures 2.2 and 2.3) indicates that the rock is acid generating. The average AP for the backslope samples (188 tCaCO₃/kt) is considerably higher than the average AP of other inactive sites, reflecting a higher sulfide content. The lower NP values for these materials relative to other samples are a result of lower carbonate contents in the rock when it was placed and depletion of carbonate from the fines fraction through weathering.

Sampling of drainage from the Mill Backslope reflects two source waters. Water from the dewatering drains has low conductivity and low metal concentrations. Precipitation that infiltrates through the pyritic production rock buttress has a higher dissolve load, dominated by sulfate, calcium, magnesium, iron, zinc and other trace metals. Some samples indicate a mixture of these two sources. Drainage from one of the dewatering manifolds (MBS 338 9) has moderate levels of iron, yet appears to have a minimal production rock component (low sulfate). This illustrates the process of iron mobility in reduced groundwater that is not related to production rock oxidation. When the reduced groundwater reaches the surface it reacts with atmospheric oxygen and produces iron oxyhydroxide (red staining). Average flows from combined Mill Backslope sources are low (less than 2 gpm) and drainage is routed to water treatment facilities via a network of drains and lined ditches.

In 2002, KGCMC applied lime to localized areas of the Mill Backslope and has utilized in-situ treatments of lime and polyacrylamide in the past. The treatments had positive short term effects on water compositions. In-situ treatment and collection and treatment of slope drainage remain the preferred near-term options for this site, because removal of the production rock would destroy the dewatering system that maintains slope stability. Long term closure options for the slope include removing the pyritic material and either replacing it with non-pyritic fill or decreasing the slope angle.

2.5 Site C

Site C is located near the end of the B Road just below the 920 mill/concentrator facilities. The site received production rock in 1987 and 1988 and currently contains approximately 50,000 cubic yards of material. The 860 safety building and assay lab have been constructed upon this site.

Results of ABA analyses (Figures 2.2 and 2.3) show that two of the five samples are potentially acid generating, however the site drainage remains near-neutral. During construction of the assay lab, glacial till from Site 23 was placed over much of the exposed production rock. The Site 23 material is not potentially acid generating and reduces exposure of the covered production rock to precipitation and oxygen. A network of drains and catchments diverts surface water away from the production rock. Flow from the production rock is low (less than 1gpm), remains near-neutral and has moderate sulfate, zinc, cadmium and iron concentrations. Monitoring in Greens Creek below Site C shows no signs of significant effects from the Site C or other sites up-gradient of the monitoring point.

Contingent on relative costs to cover or relocate the materials, KGCMC will either place a composite soil cover on the site or relocate the production rock at closure.

2.6 Site E

Site E is located 4.6 miles up the B Road halfway between the Hawk Inlet port facility and the 920 mill facility (Figure 2.1). Approximately 365,000 cubic yards of glacial till and production rock were placed at the site from 1988 to 1994. The glacial sediments were excavated from the 920 site during construction of the mill facility. Figures 2.2 and 2.3 show that six of the 20 ABA samples taken in 2002 are potentially acid generating and all but one of the samples produced rinse pH values above 6.8. Water sampling at the site demonstrates that the production rock continues to buffer the pH of the drainage near neutral. Sulfate and metal loading in surface samples is relatively high (but consistent with exposed carbonate buffered pyritic production rock) but flows are low (less than 2 gpm). Flows from the site are minimal because it sits on a topographic high and only receives water from precipitation (i.e. no run-on or groundwater input).

Plans to cover the site in 2003 with a composite soil cover were postponed pending the results of a re-evaluation of the geotechnical stability of the site, verification of performance data from the trial cover at Site 23 and an economic evaluation of reclamation alternatives. Provided there are favorable results from the stability review and cover performance monitoring, KGCMC will compare the relative costs of recountouring and covering the pile versus consolidating it with one of the other surface facilities.

3.0 Quarries

3.1 Introduction

This section of the Annual Report is in accordance with the mine’s General Plan of Operations (Appendix 11, Attachment C). Five quarry sites were developed in 1987 and 1988 to provide rock for constructing roads and other infrastructure at the Greens Creek facilities. All quarries but one (Pit 5) are currently inactive and are being used to stockpile reclamation materials (rock, organic soils and glacial till). A summary of all operational and monitoring activities performed at these five quarry sites (borrow pits) in 2002 is provided. Refer to GPO Appendix 11 for a detailed description of the sites and associated monitoring requirements.

The quarries were sampled by dividing the walls into three sub-equal sections and collecting chips across the face of each section. A sample of fines from the entire length of the quarry was also collected in addition to two samples of reclamation materials stockpiled in the quarries. The methods represent a random sampling of the quarries and stockpiled material. However, the composited nature of the samples made them subject to the “nugget effect” because pyritic rock occurs in isolated zones surrounded by sections of barren rock.

Summary statistics for KGCMC’s quarry sites are presented in Table 3.1. Acid Base Accounting data are summarized in Figures 3.1 and 3.2. Water quality data are summarized in Figures 3.3 to 3.15. The sites are discussed individually in subsequent sections. Refer to Figure 2.1 for site locations.

Alaska Department of Environmental Conservation (ADEC) reviewed the quarries and associated data in November 2002 (ADEC 2003). This section serves as a follow-up to the ADEC review and generally does not repeat data and information presented in that report.

Table 3.1 2002 Summary Statistics for Quarry Sites

	Quarries				
	Pit 405	Pit 6	Pit 174	Pit 5	Pit 7
Years Active (approx.)	1987-1988	1987-1988	1987-1988	1987-2002	1987-1997
Acreage	3	3	2	5	4
Total Volume (yds)	17,000	8,500	10,000	4,500	15,000
Prod Rock Vol (yds)	13,000	0	0	0	0
Reclamation Material (yds)	4,000	8,500	10,000	4,500	15,000
Average NP (tCaCO ₃ /kt)	33	23	12	42	9
Average AP (tCaCO ₃ /kt)	115	11	30	25	10
Average NNP (tCaCO ₃ /kt)	-82	12	-18	17	-1
Average Rinse pH	5.7	6.7	5.3	8	6.5

ND (not determined)

Acid Potential (AP) is compared with Neutralization Potential (NP) in Figure 3.1. The distribution of AP and NP values is considerably less than that of inactive production rock sites shown in Figure 2.2. There is typically less pyrite and carbonate in the quarry rock relative to mine production rock. Two of the five quarries (Pit 6, Pit 5) contain little or no potentially acid generating rock. The remaining three quarries (Pit 405, Pit 174 and Pit 7) had multiple samples

of potentially acid generating rock (upper left half of Figure 3.1). One of the potentially acid generating samples from Pit 7 is actually peat, which contains organic acids. This sample does not indicate the potential for acid production from sulfide oxidation. Pit 405 and Pit 174 are the only quarries that have significant zones of potentially acid generating rock.

Figure 3.1 2002 Quarry Site Acid Base Accounting Data

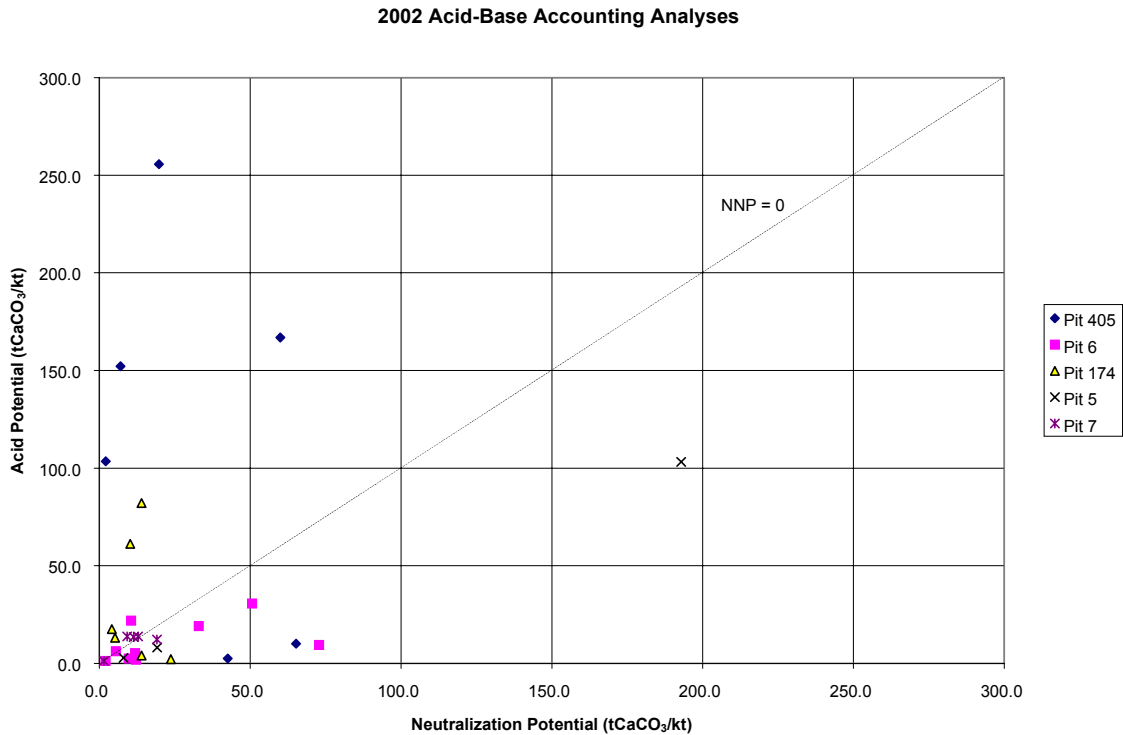


Figure 3.2 shows the relationship between rinse pH and net neutralization potential (NNP) for quarry samples. See Section 2.1 for a description of NNP and the differences between rinse pH and paste pH. Twenty of the 30 samples produced a rinse pH greater than 6.0, demonstrating maintenance of buffering capacity. Eight samples from pit walls (mainly Pit 405 and Pit 174) show evidence of buffering capacity depletion. A sample of exploration drill core stored at Pit 5 produced a pH of 5.3, but this sample is not representative of the native rock exposed in the quarry walls. Similarly, a sample of peat stored in Pit 7 produced a pH of 5.8.

Flow data for the quarry sites are presented in Figure 3.3. Much of the flow data was collected during or shortly following storm events and represents maximum flow values. Flow estimates vary from just over 100 gpm to less than 1 gpm with most less than 10 gpm. The bowl-shaped geometry and low permeability of the quarry walls and floors tend to focus flow toward the entrance of the pits.

The amount of reactive surface area available for sulfide oxidation is considerably less for quarries than for production rock piles. Oxidation is limited to the non-coated outer face of the quarry wall and near surface fractures. Lower sulfide contents and smaller surface area yield a lower flux of oxidation products from quarries compared to production rock sites.

Figure 3.2 2002 Quarry Site Rinse pH Data

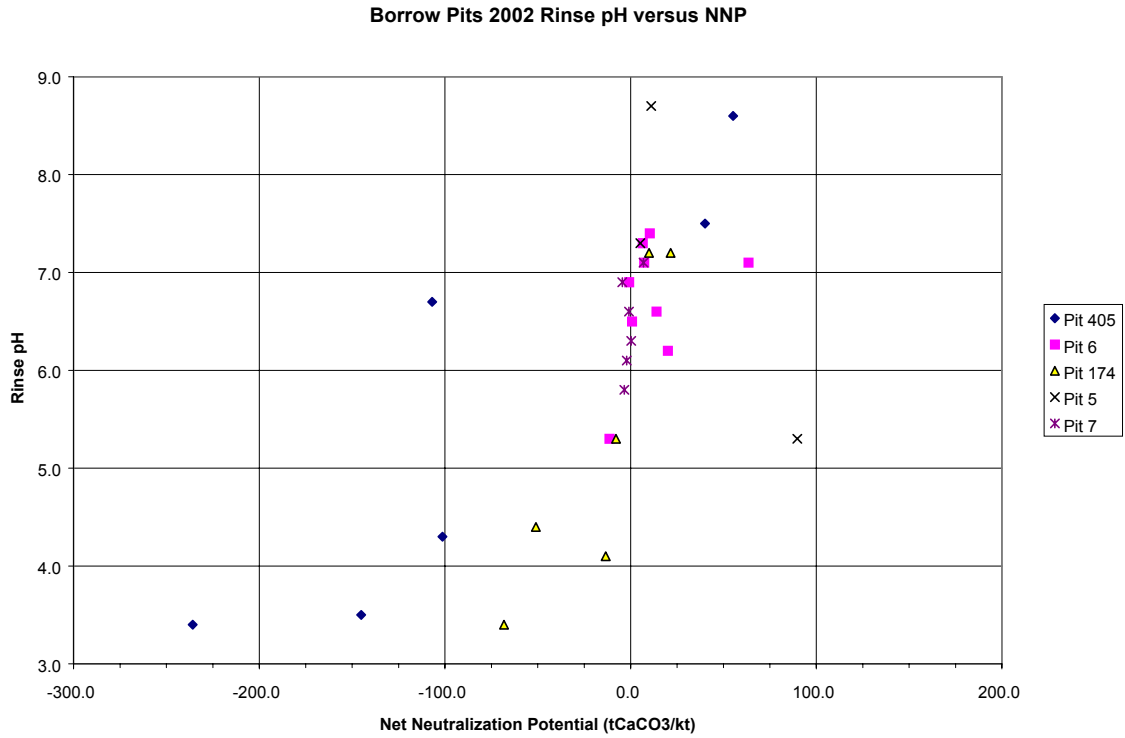


Figure 3.3 Quarry Site Flow Data

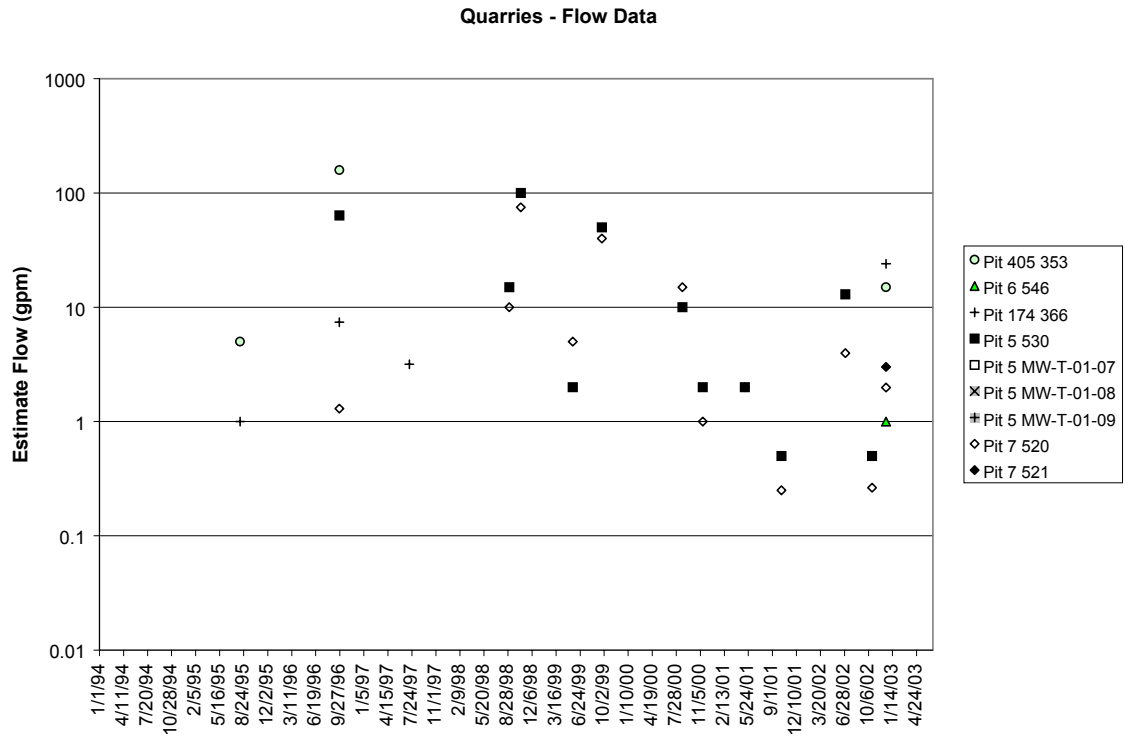
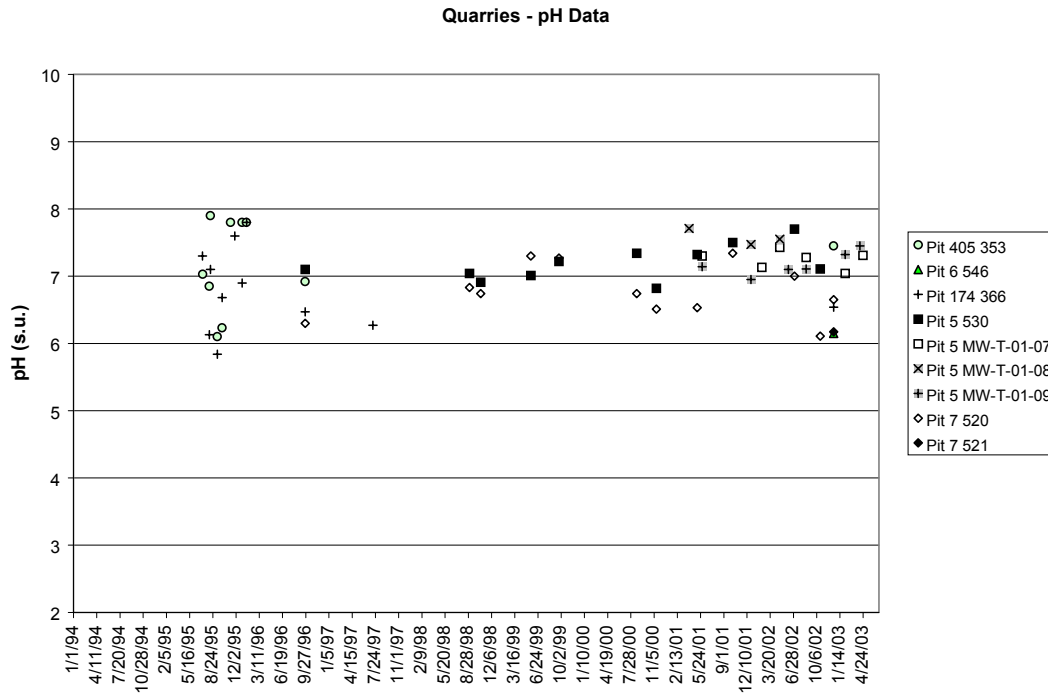


Figure 3.4 shows pH data from the quarry site sampling locations. Of 61 samples taken since 1995, 60 have pH values between 6.0 and 8.0. A pH of 5.8 was recorded from Pit 174 in 1995, but more recent samples average approximately 6.5. The difference between field drainage pH values in Figure 3.4 and the laboratory rinses pH values in Figure 3.2 is significant. The data show that the limited exposures of stored oxidation products (represented by rinse pH data) do not have a significant effect on the drainage from the sites (field drainage data). Alkalinity data presented in Figure 3.5 are consistent with the pH results, with all sites maintaining measurable alkalinity provided by dissolution of carbonate minerals. The lower alkalinity value from Pit 6 represents influences from organic acids derived from forest soils (note associated low conductivities of Pit 6 samples). Sample sites with the highest alkalinity are groundwater monitoring wells in Pit 5. Pit 5 has the highest carbonate content of the quarries and also may show influences from the water treatment plant located at that site and the continued quarrying activity.

Figure 3.4 Quarry Site pH Data



Conductivity data are shown in Figure 3.6. Conductivity indicates the amount of dissolved constituents in the water. Samples having higher conductivity values usually have higher sulfate, calcium and magnesium (hardness) concentrations, reflecting influences from sulfide oxidation and carbonate mineral dissolution. With the exception one well in Pit 5 (MW-T-01-07), all conductivity data are consistent with waters derived from relatively freshly exposed low to moderately mineralized quarry rock. MW-T-01-07 has considerably higher conductivity, which may reflect an influence from the Pit 5 water treatment plant. Past treatment plant upsets have contributed water to the area around the plant. This well and its relationship to the treatment plant and the tailings facility is discussed in more detail in KGCMC 2003. The results for sulfate, magnesium and hardness, shown in Figures 3.7, 3.8 and 3.9, respectively, correlate with conductivity results.

Figure 3.5 Quarry Site Alkalinity Data

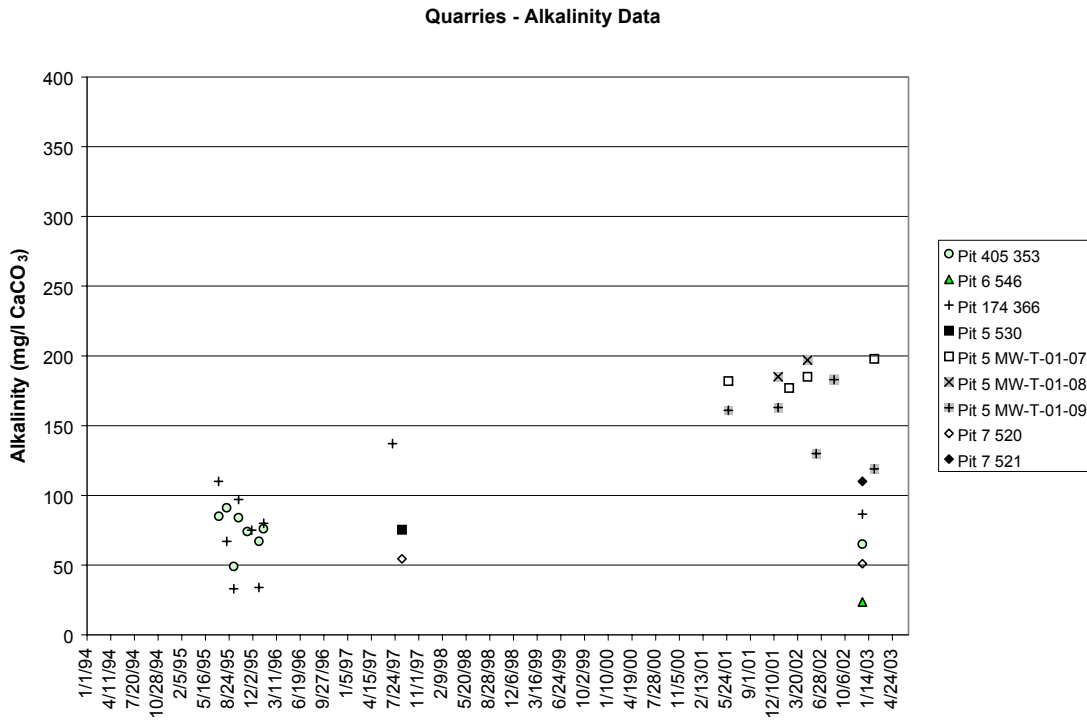


Figure 3.6 Quarry Site Conductivity Data

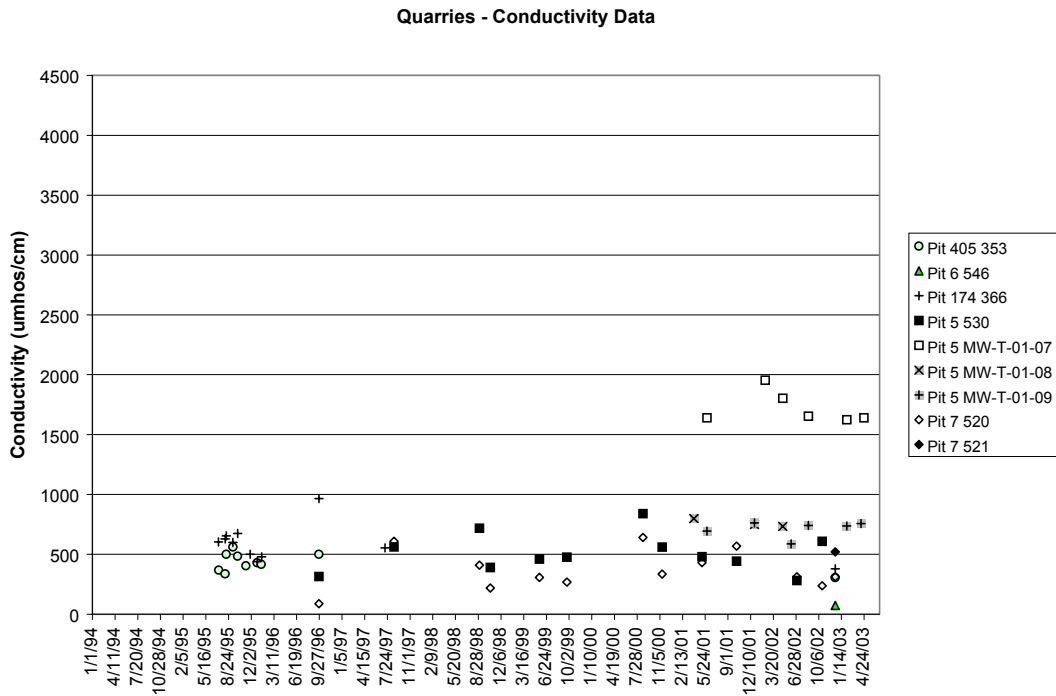


Figure 3.7 Quarry Site Sulfate Data

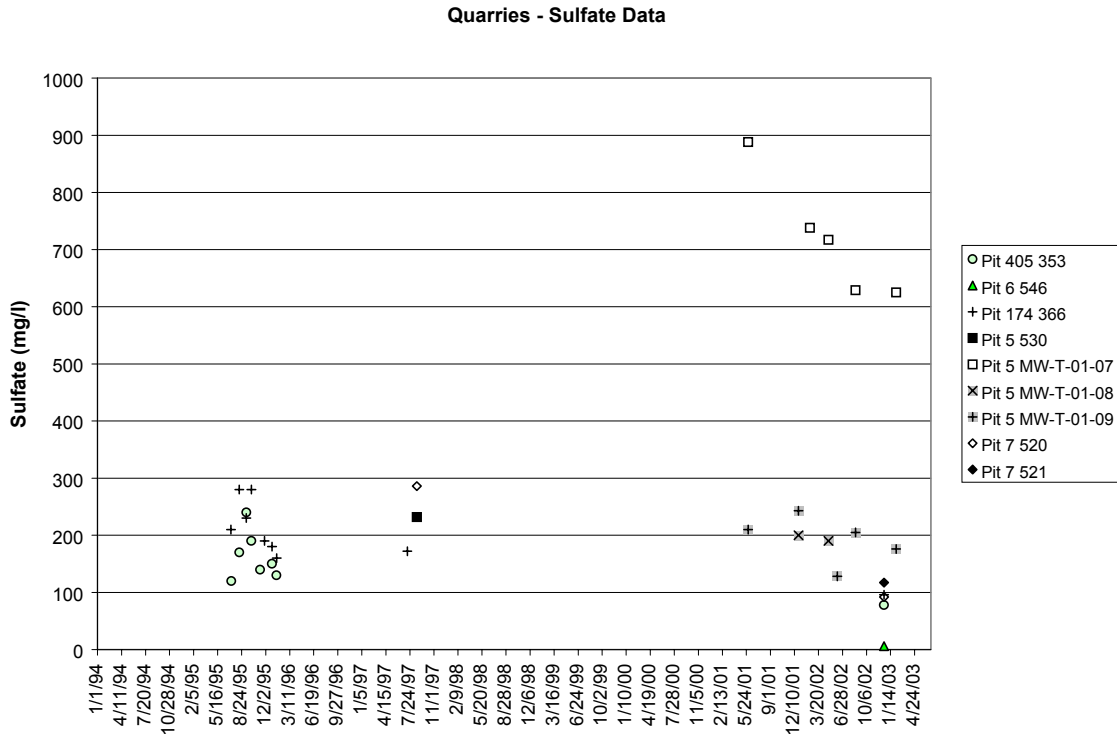


Figure 3.8 Quarry Site Magnesium Data

Quarries - Magnesium Data

Non-detect results shown at 1/2 detection limit; Data are a composite of dissolved, total and total recoverable results

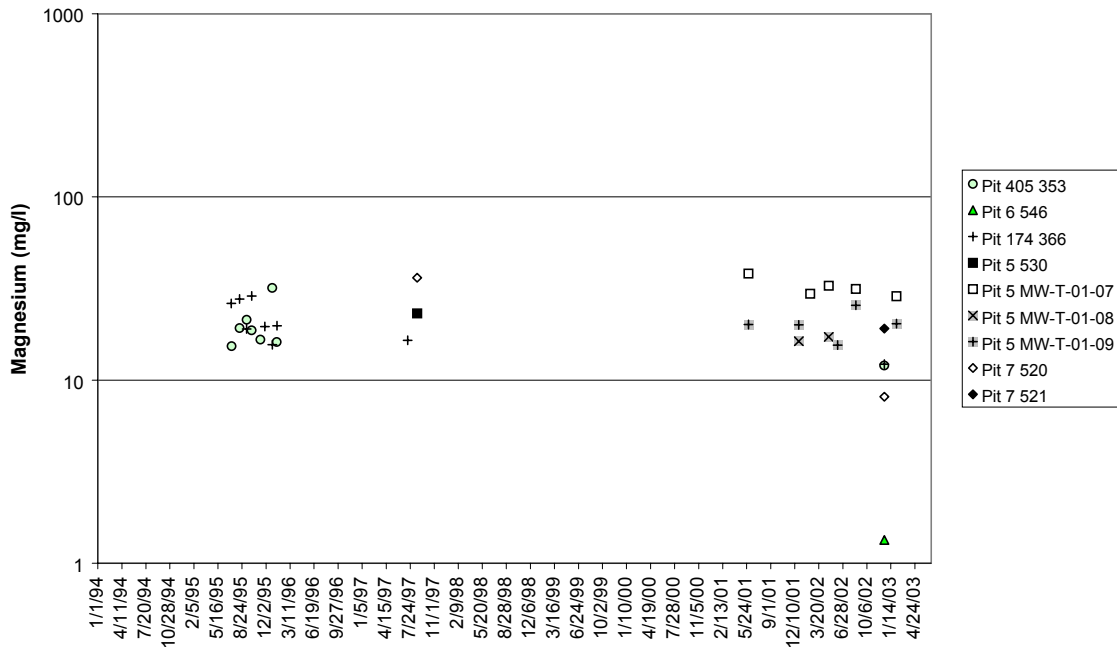
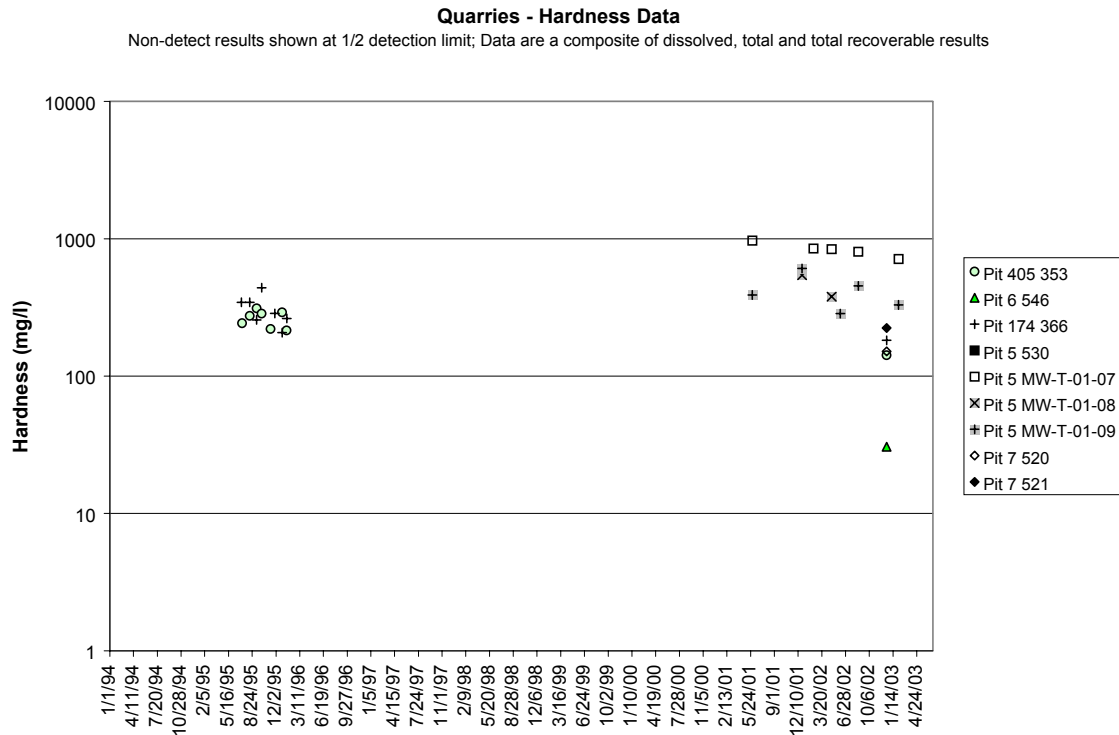


Figure 3.9 Quarry Site Hardness Data



The data for zinc, copper, lead, cadmium, nickel and arsenic are presented in Figures 3.10 to 3.15. Sample results that were less than the detection limit are plotted at one half the limit value. While this allows the results to be plotted on a logarithmic scale, it causes non detect results with high detection levels to appear more concentrated than they actually are. Detection limits have varied with time and are often evident on the graphs as horizontal groupings of symbols. The results for metals generally correlate with conductivity values. Zinc concentrations reflect the higher solubility of this element relative to the others. Metal loads from quarry sites have been consistently relatively low and either remained relatively constant or decreased with time. The decrease in metal loading is attributed to a reduction or reactive surface as reactants are consumed and coatings form on mineral surfaces.

Closure options for pyritic pit walls are relatively limited. Since there are no proven long term surface treatments available, it is best to let naturally occurring coatings that have formed over the past 15 years to continue to form. As the coatings form and the amount of available pyrite decreases, so too will the dissolve load.

Figure 3.14 Quarry Site Nickel Data

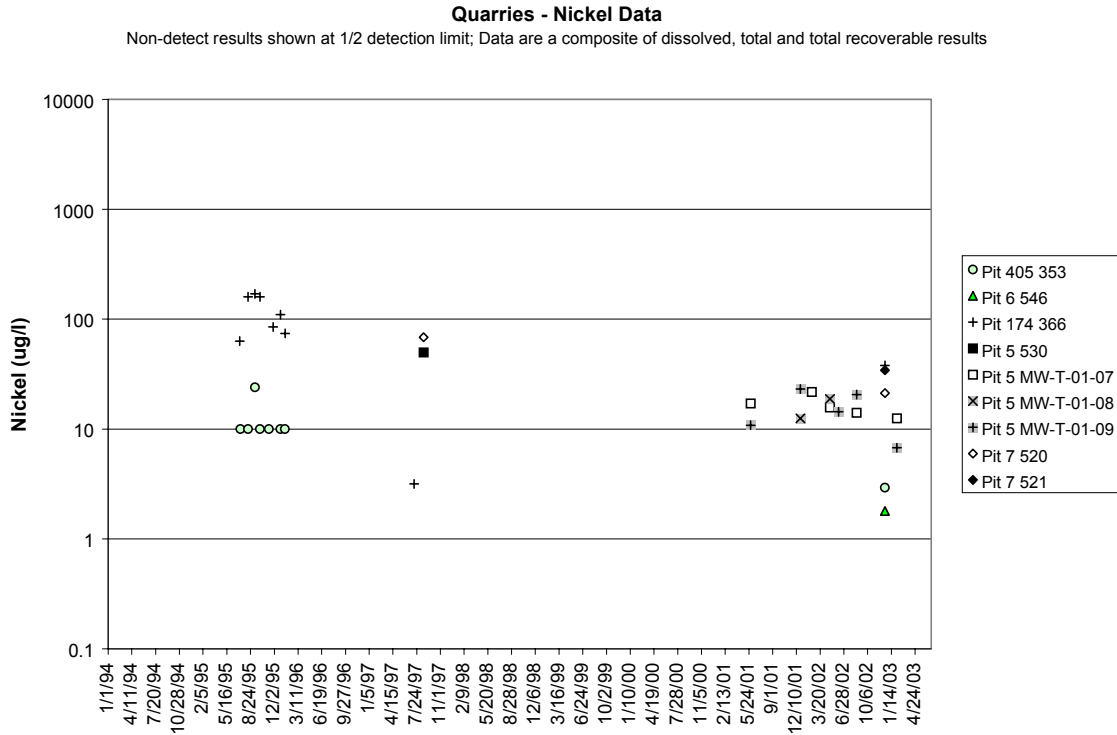
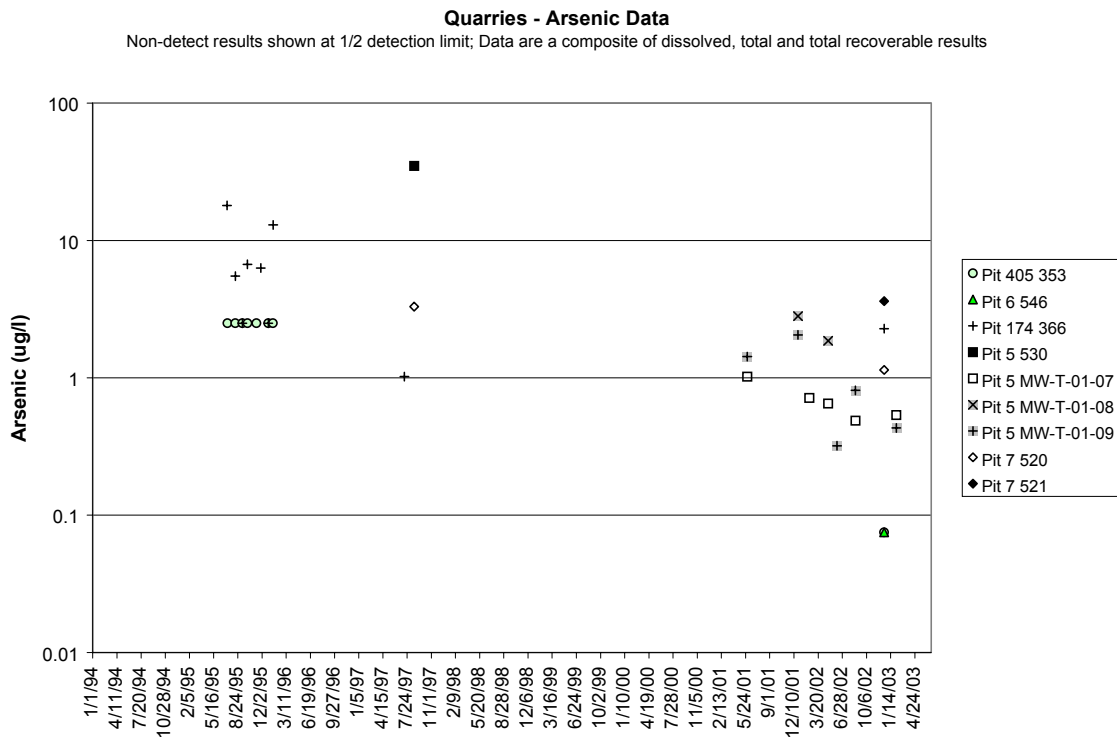


Figure 3.15 Quarry Site Arsenic Data



3.2 Pit 405

Pit 405 is located at 7.6 mile on the B Road. The rock from this quarry was used for construction of the B Road and other mine infrastructure. Mine records indicate that approximately 12,000 cubic yards of production rock were backfilled into the quarry in 1988. The quarry received reclamation materials (colluvium and glacial till) in 1994, 1995 and 1998 for use in future reclamation projects. Acid base accounting data (Figures 3.1 and 3.2) from samples of the exposed pit walls indicate the presence of acid generating rock zones (approximately one third to one half of the exposure). However, monitoring of drainage down-gradient of the quarry (Figures 3.3 to 3.15) demonstrates that influences from the site are negligible. Barring a significant change in downstream water quality, the site will be reclaimed when the reclamation materials stored in the quarry have been utilized at other sites. The production rock in the quarry will either be removed or covered in-situ. Removal of the rock would increase exposure of the pyritic quarry wall.

3.3 Pit 6

Pit 6 is located at 4.6 mile on the B Road across from Site E. The quarry produced rock for construction of the B Road in 1987. Reclamation materials (approximately 10,000 cubic yards) were hauled to the site from the Site 23 and the 920 facility. ABA analyses indicate that the majority of the rock exposed in the pit does not have the potential to generate acid. Monitoring of surface drainage from the pit access ramp indicates no significant influence from the pit walls or stored material. Reclamation materials will be used to reclaim Site E or other mine facilities.

3.4 Pit 174

Pit 174 is located at 3.3 mile on the B road and was used for road construction in 1987. The pit has been partially backfilled with reclamation materials that will be used to reclaim other site facilities. ABA data from pit walls indicate that some zones in the rock are potentially acid generating (Figures 3.1 and 3.2). However, pyritic zones account for a small fraction of the pit wall exposure. Drainage from the site has an average pH of 6.8 (Figure 3.4). Sulfate and metal concentrations in the pit drainage are moderate, however flows are generally low (typically less than 10 gpm during rain events). Iron staining periodically occurs in the drainage below the site which collects runoff from this quarry and surrounding areas. Once the stored reclamation materials (rock, organic soils and glacial till) are utilized, the site will be reclaimed. Reclamation goals include minimizing runoff from the exposed pit wall and covering as much of the exposed pyritic rock as possible by placing a wedge of glacial till at the base of the wall.

3.5 Pit 5

Pit 5 is located just north of the tailings facility at 0.8 mile on the B Road. Pit 5 currently houses the water treatment plant. Rock from the pit was used for construction of roads and other surface facilities infrastructure. Approximately 12,000 bank yards of rock were quarried from Pit 5 in 2002. Approximately 8000 yards of the rock were used to construct access roads on the tailings pile, and the balance is stockpiled in the pit. ABA analyses from pit walls indicate that the rock does not have the potential to generate acid, although it does contain small diffuse amounts of pyrite, often occurring as isolated euhedral cubes. Drainage from the site monitored at a surface stormwater site is dominated by sulfate, calcium and magnesium and has moderate to high concentrations of several trace metals (Figures 3.10 to 3.15). This drainage is routed to the water treatment facilities via the North Retention pond located near the B Road. The ditch receives surface flow from the pit and may also be influenced by near-surface flow from the tailings pile.

Final reclamation of the pit is contingent on the ultimate design and construction of the tailings pile.

3.6 Pit 7

Pit 7 is located at 1.8 mile on the A Road between Hawk Inlet and Young Bay. The pit was initially developed in 1987 to support construction of the roads and other mine facilities. Pit 7 has been partially backfilled with reclamation materials derived during expansion of the tailings pile. Iron staining has been observed in some drainage from the pit, and the source of the iron appears to be the peat and gravels stored in the pit rather than from the pit walls themselves. Temporary hydro-seeding of the peat has resulted in a productive grass cover of these materials. Minor iron staining occurs on the southern wall, but it is limited in extent. ABA analyses from the samples of the pit walls (Figures 3.1 and 3.2) indicate the potential for acid generation, however the sulfur content of the samples is relatively low, less than 0.5%. As discussed above the composited nature of the sampling is subject to nugget effects. The pyritic zones are a minor component of the overall pit. A sample of stockpiled peat produced ABA results indicating slightly acid generating material. This is consistent with acidity caused by organic acids, not sulfide oxidation and is not considered a negative result. Monitoring of drainage from the pit (Figures 3.4 to 3.15) demonstrates that the pit does not have a significant effect on down gradient receiving water. Relatively low sulfate concentrations (approximately 100 mg/l) and low metal values support the conclusion that sulfide oxidation and metals leaching is not significant at Pit 7.

Following removal of stockpiled capping materials for reclamation of other sites, the site will be contoured and hydroseeded. The potential exists to create more wetlands similar to those previously constructed near the entrance to the pit.

4.0 References

Alaska Department of Environmental Conservation (ADEC), 2003, Memorandum – November 4, 2002 Site Visit KGCMC Other Sites Not Covered By Waste Disposal Permit, January 2003.

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Shepherd Miller, 2000, Technical Review ARD/Metals Leaching and Freshwater Monitoring Plan Greens Creek Mine, February 2000.