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APPENDIX 4

REPORT ON URANIUM ACTIVITIES IN RÖSSING GROUND WATER SAMPLES

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REPORT ON URANIUM ACTIVITIES IN RÖSSING GROUND WATER SAMPLES

EXECUTIVE SUMMARY

The uranium dissolved in the water percolating through the freshly ground rock on the tailings dam is clearly distinguishable from the uranium in water from the Swakop and Khan rivers by means of the ratio of ^{238}U and its daughter isotope, ^{234}U. There is no evidence that uranium from the mining activity has reached the lower reaches of the gullies, Pinnacle, Panner and Dome, draining towards the Khan River, or the Khan River itself. The precautions to avoid this, therefore, appear to be adequate.

It is recommended that further water samples from the gullies downstream of the tailings dam be analyzed to establish the extent of the local pollution plume and that selected well-points be monitored in future.

1. INTRODUCTION

Large volumes of water are used in the mining and extraction activities at Rössing Uranium Ltd and elaborate precautions have been taken to avoid contaminating the water in the sand bed of the adjacent Khan River. In order to investigate whether these measures are effective uranium isotope analyses were undertaken on selected water samples from the environment of the mine.

1.1 Rationale

The Central Namib Desert is known to have high levels of uranium in the surface layers on the peneplain. This uranium is probably derived from the weathering of the uranium bearing rocks in the area. High levels of dissolved uranium in the ground water and in the river beds thus do not necessarily indicate uranium pollution caused by the modern mining activity. Uranium derived from freshly ground rock can, however, be distinguished from uranium dissolved during natural weathering of surface rocks by means of the activity ratio of the uranium isotope ^{238}U and its daughter isotope ^{234}U. Under natural conditions dissolved uranium has an activity ratio, $^{234}U/^{238}U > 1$, while uranium dissolved from freshly broken rock shows a ratio = 1 (Kronfeld & Vogel, 1991).

Analysis of this isotope ratio in selected water samples from the surroundings of the Rössing mine should thus show the extent of any uranium contribution from the mining activity.

1.2 Samples

Twelve water samples were collected in March 1997 from well-points at and around the mine for uranium isotope analysis. Details are listed in **Table 1**. The samples include water from the mine tailings dam, the potential source of contaminated water. Samples were also collected from the trenches in the Pinnacle and Panner Gorges. These trenches trap the water outflow from the mine, and could potentially contain some uranium pollution. Further samples were collected in the Khan River upstream and downstream from the area that is utilised by Rössing. Similarly water samples from the Swakop River were collected.

Table 1: Collection dates and descriptions of samples

Sample No.	*Name*	*Date*	*Description*
G4197	SRK1	12/03/97	Ground water seepage from the tailings dam
G4194	Seepage Dam	12/03/97	Surface seepage from the tailings dam
G4207	Borehole K	12/03/97	Ground water at mouth of Dome Gorge, some mixing with Khan
G4206	Pinnacle	12/03/97	Ground water in alluvium of Pinnacle Gorge downstream of tailings dam
G4208	Panner	12/03/97	Ground water in alluvium of Panner Gorge
G4195	Transect 0	10/03/97	Khan ground water upstream of the mine
G4196	Transect 5	10/03/97	Khan ground water downstream of the mine
G4064	Borehole 1.9	11/11/96	Southern tributary of Khan, draining uranium occurrence
G4210	Borehole 1.10	10/03/97	Khan ground water close to the Swakop confluence
G4212	Haigamkab	10/03/97	Swakop ground water upstream of the Khan confluence
G4209	Palmenhorst	10/03/97	Swakop ground water downstream of the Khan confluence
G4211	Goanikontes	12/03/97	Swakop ground water far downstream of the Khan confluence

2. MEASUREMENT AND RESULTS

Due to time restraints only ten of the twelve samples were processed. The following procedure was followed for each of the samples that were analyzed: Up to 100 mℓ of water was used, depending on the expected uranium concentration of the water. The sample was acidified and spiked with a known amount of $^{232}U/^{228}Th$. The uranium was concentrated by co-precipitation with $Fe(OH)_3$ and the precipitate purified by ion exchange and solvent extraction. The uranium was then electroplated onto stainless steel planchets and the radioactivity determined by alpha spectrometry (Kronfeld & Vogel, 1991).

The results are listed in **Table 2** and shown on the accompanying map (**Figure 1**).

Table 2: Uranium activity ratios and concentrations from Rössing

Sample	$^{234}U/^{238}U$	U ppm
Contaminated samples		
SRK1	1.001 ± 0.013	2.711 ± 0.090
Seepage dam	0.996 ± 0.006	4.051 ± 0.065
Gorges into Khan River		
Pinnacle trench	1.297 ± 0.019	0.835 ± 0.029
Panner trench	1.272 ± 0.023	0.333 ± 0.010
Borehole K	1.296 ± 0.044	0.693 ± 0.051
Borehole 1.9	1.150 ± 0.013	1.210 ± 0.019
Khan River		
Transect 0	1.295 ± 0.021	0.128 ± 0.002
Transect 5	1.320 ± 0.031	0.129 ± 0.004
Swakop River		
Haigamkab	1.511 ± 0.089	0.033 ± 0.002
Palmenhorst	1.408 ± 0.051	0.120 ± 0.005

3. DISCUSSION AND INTERPRETATION

The uranium concentrations of all the samples are very high; compared with those in South African rivers (Kronfeld & Vogel, 1991) they are some three orders of magnitude higher.

As was to be expected, the two samples draining the tailings dam directly have the highest concentrations, viz 2.7 and 4.1 ppm. As predicted, the isotope activity ratios are unity thus clearly characterizing the freshly leached uranium. The local gullies draining into the Khan River also have considerably higher uranium contents than the water from the river bed itself. This is not surprising in view of the proximity of uranium ore. Borehole 1.9 drains an ore outcrop on the south side of the river. Chemical weathering of this ore explains the high concentration of 1.2 ppm and the relatively low activity ratio of 1.150 ± 0.013. The latter is nevertheless distinctly different from the ratios in the polluted water.

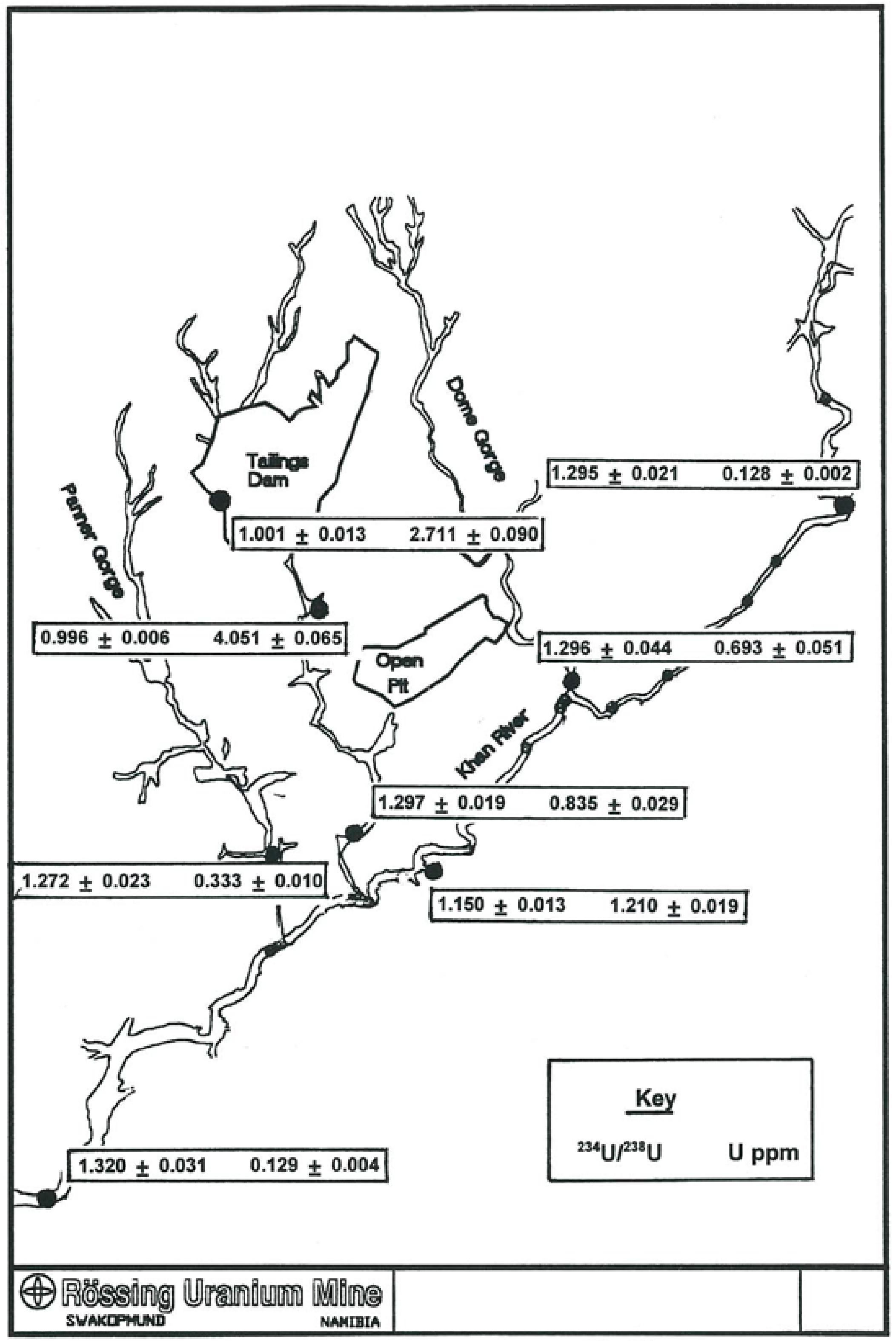

Figure 1: Map of the Rössing Mine area with $^{234}U/^{238}U$ ratio and Uranium concentration in ppm of water samples indicated.

The activity ratios in the other gullies are statistically indistinguishable from those in the Khan River (c. 1.3) and clearly represent the solution conditions in the area. The evidence of those data is, therefore, that insignificant amounts of uranium polluted water has reached the sampling points in the Pinnacle, Panner or Dome Gorges or the Khan River itself. Using a 2σ criterion, the activity ratios suggest that less than 1% of the water in the Pinnacle and Panner trenches can have been derived from the tailings dam.

The uranium content in the Swakop River bed (0.033 ppm), increases after the junction with the Khan river to 0.120 ppm and the isotope activity ratio decreases accordingly, reflecting the water contribution from the tributary.

4. CONCLUSION

The data presented here indicate that the measures taken to avoid radioactive pollution reaching the water in the Khan River bed have, thus far, been successful. There is no evidence of uranium pollution being added to the environment by Rössing activities, although the background uranium concentrations in the area are fairly high relative to South African conditions.

5. RECOMMENDATION

It is recommended that selected water samples be analyzed at regular intervals in future to monitor the progress of the polluted ground water near the tailings dam. Samples should be collected between the tailings dam and the trenches in the Pinnacle and Panner Gorges where the current samples were taken. This will indicate how far towards the Khan River any uranium pollution has progressed. It is conceivable that seepage from the tailings dam could reach the Khan River along fault lines that are not connected with the alluvium in the gullies and it would be advisable to also sample other well-points in the river bed.

Radiocarbon analysis of the water in the Khan River bed would furthermore allow an assessment of the turnover time of the aquifer.

6. REFERENCE

Kronfeld, J. & Vogel, J.C. 1991. Uranium isotopes in surface waters from southern Africa. *Earth and Planetary Science Letters* 105:191-195.