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X-Ray diffraction analysis of deposits from the Fuji 30 MW turbine at Svartsengi, Iceland

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X-Ray Diffraction analysis of deposits from the Fuji 30 MW turbine at Svartsengi, Iceland

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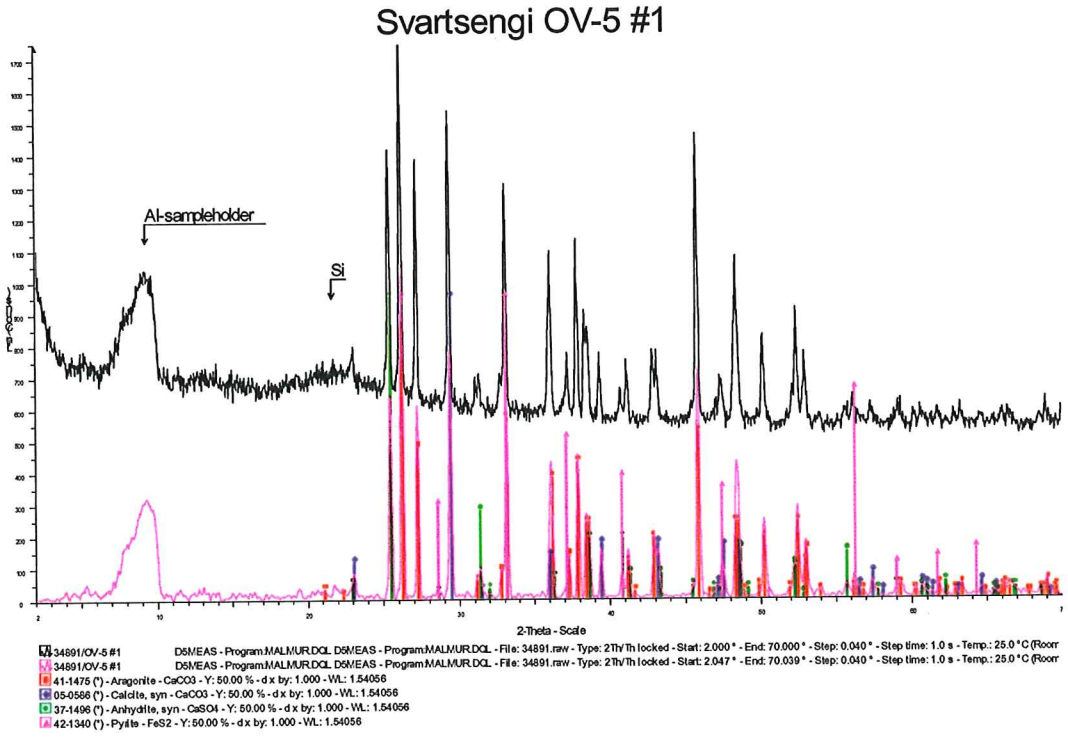
Sverrir Thorhallsson

X-Ray Diffraction analysis of deposits from the Fuji 30 MW turbine in OV-5 at Svartsengi

Samples where collected at the request of Albert Albertsson of deposits from the turbine's interior on the 17th of May, 2002 by Magnús Ólafsson and Sverrir Thorhallsson from Orkustofnun-ROS. At that time the turbine had already been cleaned with high-pressure water and undisturbed samples were only obtained from blade holder #1 that had not yet been cleaned (Fig 1). Sigurdur Sveinn Jónsson at ROS XRD-laboratory prepared the samples and identified the crystallized phases. The peaks in count were matched against PDF-2 data base series 1-46 from ICDD. All relevant peaks are accounted for, as can be seen from the XRD diagrams. These results were reported by E-mail 21.05.2002.

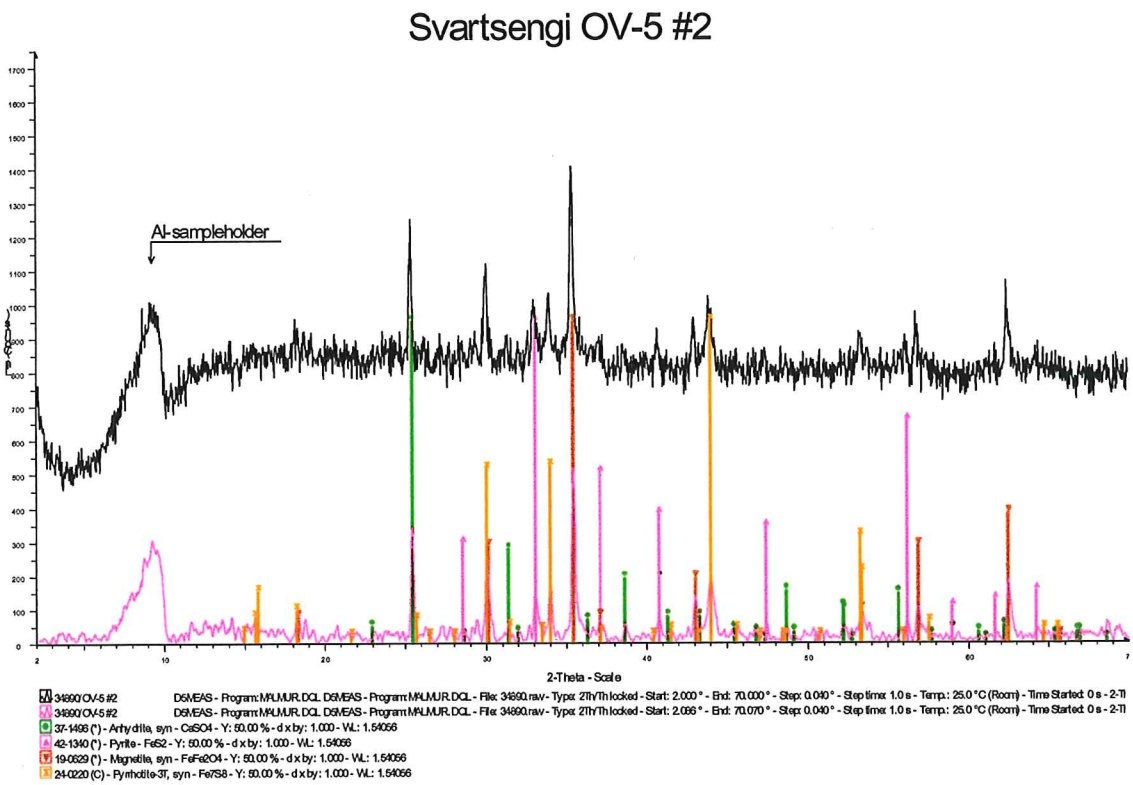
The samples where dried, crushed in a mortar and transferred to a sample holder of aluminum with a glass backing. Two of the samples where not sufficiently large to be placed in a Al-sample holder and a thin zero-background qz-plate was used instead. The samples where scanned from a low-angle of 2° (2Θ) up to 70° (2Θ). The diffractometer used is a Phillips PW1710. Anode used was Cu kα, at 40 kV and 20 mA.

Sample #01.
Precipitation from the back side of the inlet nozzle blades (Fig 3), (on exhaust side) is made nearly entirely of crystalline Ca-carbonate ($CaCO_3$) and both calcite and aragonite are present (Fig. 1). A small peak of anhydrite ($CaSO_4$) is present and traces of iron sulfide (probably pyrite- FeS_2). A small hump representing the presence of some amorphous silica is only noted in this sample.



Sampe #02

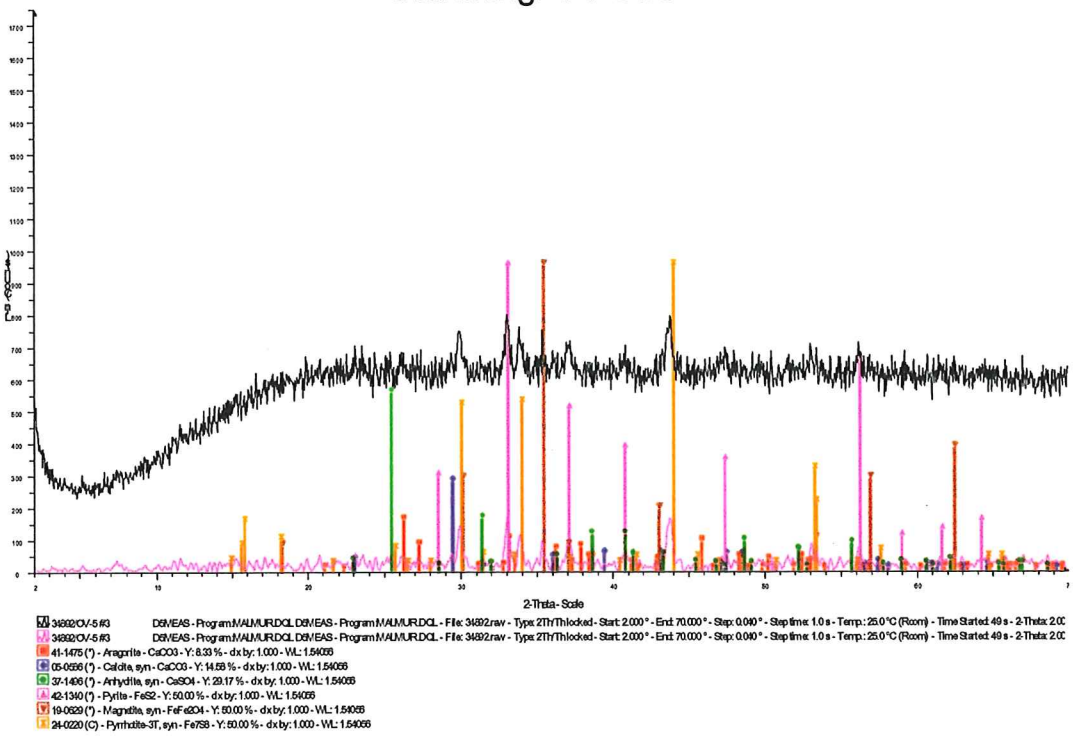
Sample taken in sealing fins opposite the tip of the first turbine stage (moving blades) (Fig 2). The shroud of the first stage was worn down (Fig. 4). The sample is moderately crystallized, showing rather high background radiation due to a high content of iron, but the bulk of the sample is a mixture of iron-compounds, mostly iron oxide (magnetite Fe_3O_4, magnetism not confirmed) but iron sulfides FeS and FeS_2 are also present. The iron could be on some other oxidation state. One peak from anhydrite $CaSO_4$ is present but carbonates are absent and so is amorphous silica.



Sample #03

Sample scraped from the back of moving blade of stage 8. A very-very thin crust was collected from the blade, but previously the blade had been washed with high-pressure water. A very high background is an indication of a very high iron content, and peaks for iron compounds are present (magnetite Fe_3O_4, pyrite FeS_2, pyrrhotite FeS) similar to sample #02.

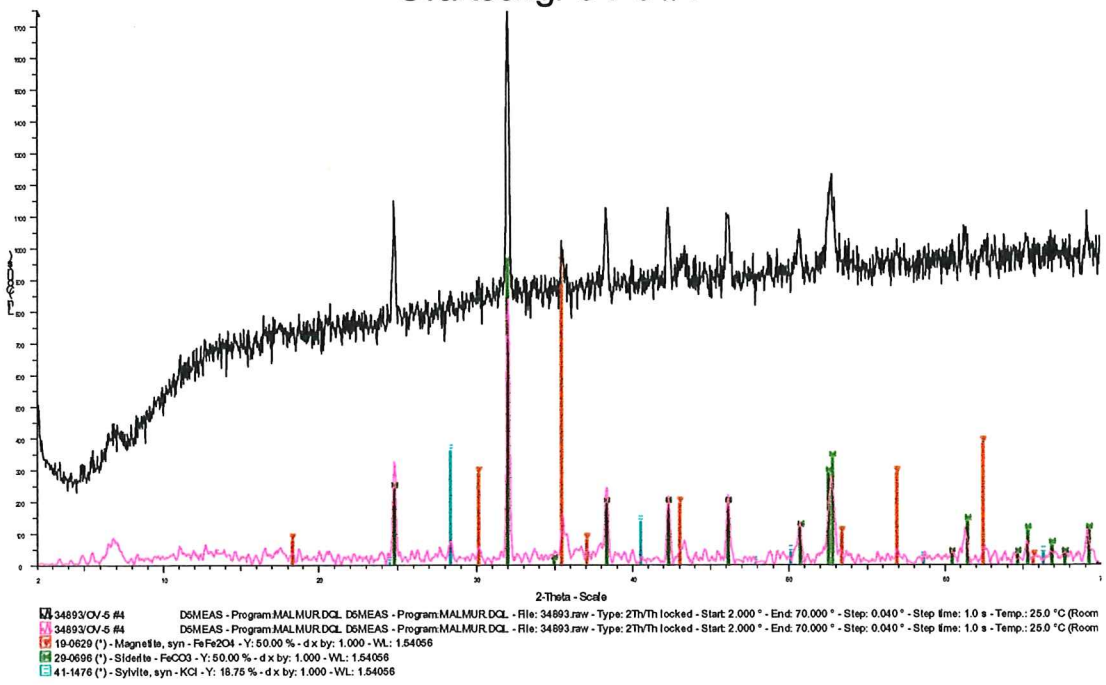
Svartsengi OV-5 #3



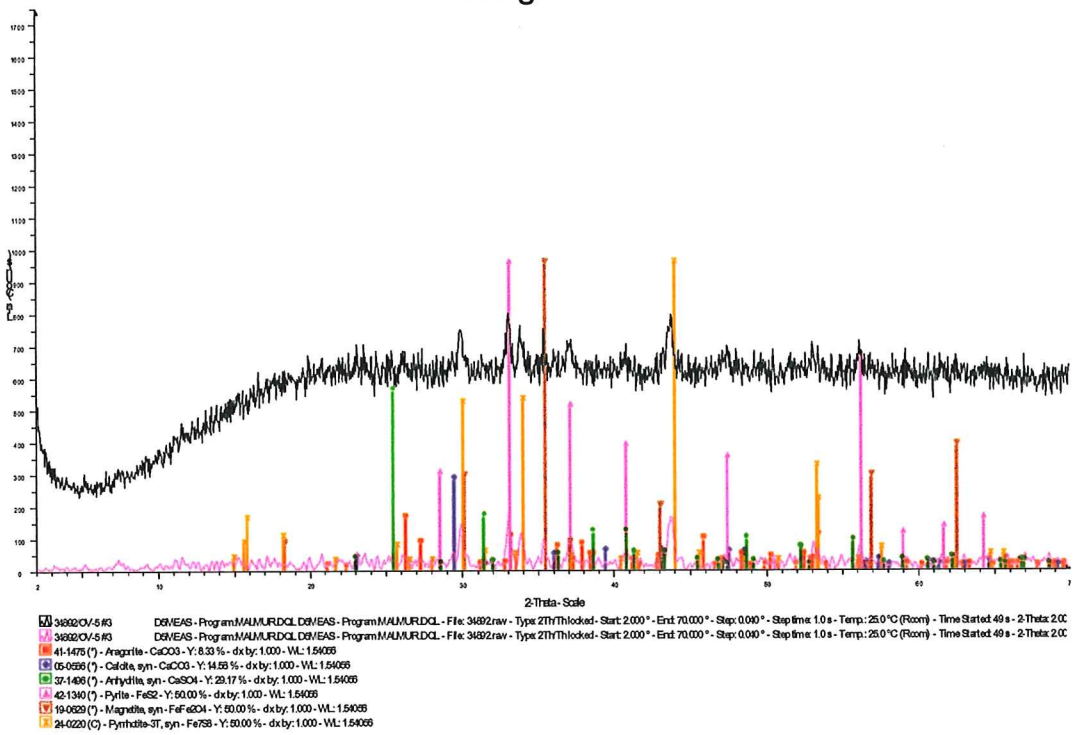
Sample #04

Sample taken from lower half of the turbine casing, by the eighth stage. Background is high (high Fe-content) and the mostly abundant crystallized phase is the iron-carbonate siderite ($FeCO_3$). Other iron compounds are also present (magnetite? Fe_3O_4). A trace of sylvite is present (KCl).

Svartsengi OV-5 #4



Svartsengi OV-5 #3



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Svartsengi OV-5 #4

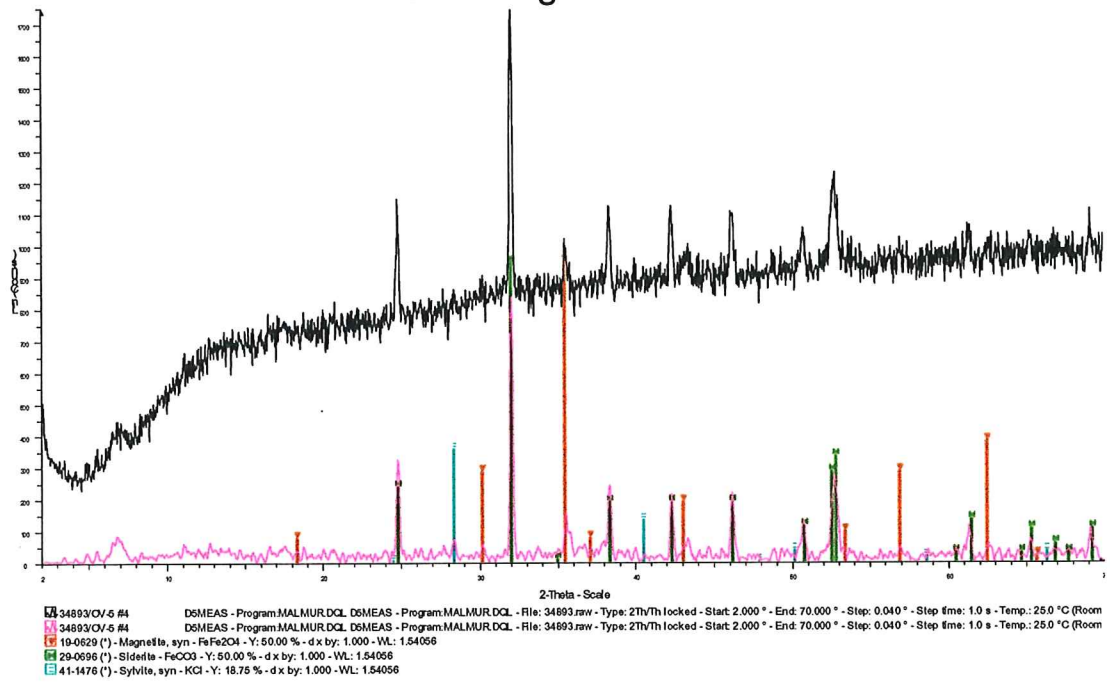

Figure 1. Blade holder #1 where samples #1 and #2 were collected.

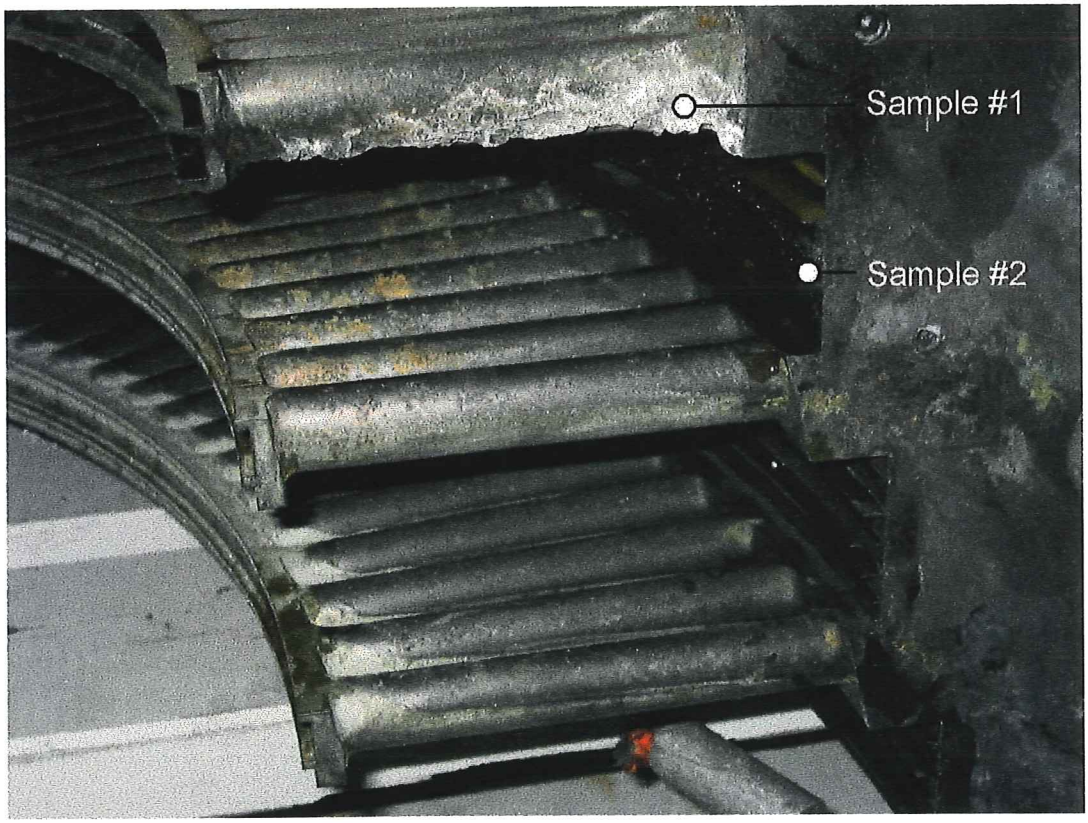

Figure 2. Close-up of sampling sites, clearly showing the amount and type of deposits. Sample #1 from light coloured scales in the inlet nozzles, sample #2 of black deposits by sealing fins against shroud of 1st stage moving blades.

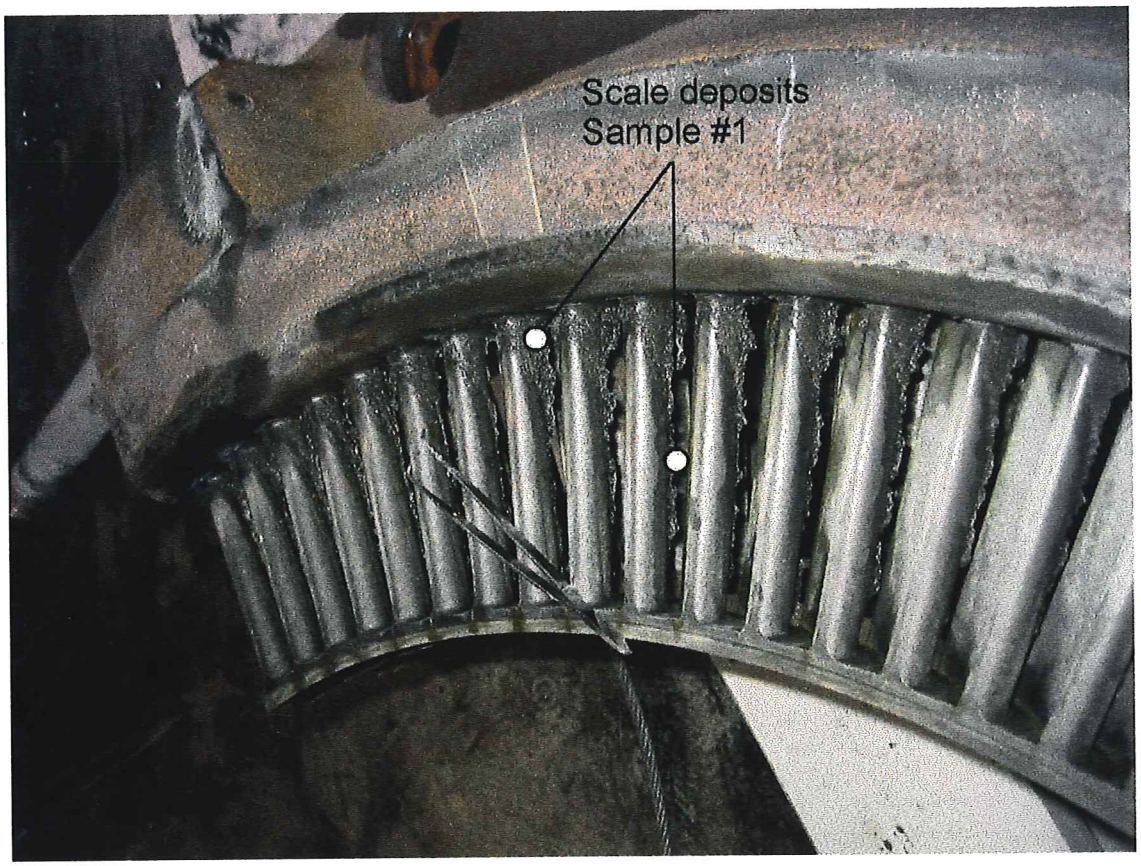

Figure 3. Close-up of scale deposits on the back-side of the inlet nozzle blades, sample #1.

Figure 4. Turbine rotor after washing. Sample #3 was a very – very thin film from the 8th stage.

Figure 5. Rotor wear on 1st stage shroud opposite the sealing fins where sample #2 is taken. Photograph taken after initial high-pressure water washing of turbine rotor.

Figure 6. Upper half of turbine casing after initial high-pressure water washing. No deposition was remaining that could be removed for analysis.

Figure 7. Sample # 4 in lower half of turbine casing.

ORKUSTOFNUN
Rannsóknasvið

Greinargerð
SSJo-02/25.

21-05-02

Orkustofnun
Verkfræðideild
c/o Sverrir Þórhallsson
Unnið fyrir Hitaveitu Suðurnesja.

XRD-greining – könnun á útfellingum úr hverfli í Orkuveri-5.

Sýnin sem bárust voru tekin úr hverfli í Orkuveri 5. Eitt sýni var grátt hrúður og hin þrjú voru svört. Sýnin voru mölið í mortéli og tvö sett á Al-sýnahaldara en tvö á Qz-sýnahaldara. Mælt var frá lág-horni (2Θ=2°) til að sjá hugsanlega toppa á 10-20 Å og að 2Θ=70° en þá má gera ráð fyrir að flestir toppar sjáist. Notaður var X-ray diffractometer ROS af gerðinni Philips PW-1710, með Cu kα-geislun á 20 mA og 40 kV. Mæliskrá sem notuð var heitir *malmur.dql.*

#01 er nær eingöngu kalsít og aragónít. Nokkuð er af anhýdríti í sýninu og [illegible]vottur af pýríti. Annars er um að ræða tiltölulega hreint sýni og örlítill vottur af kísli er merkjanlegur.

#02 er blanda af járnsúlfíðum og járnoxíðum (pyrrótít, pyrít, magnetít). Mest áberandi er magnetít. (segulmögnun ekki könnuð) en það gæti verið að járnið sé á einhverju öðru oxunarstigi. Hár bakgrunnur bendir eindregið til hás járninnihalds. Einn toppur sem er merktur og á hann við anhýdrít.

#03 mjög hár bakgrunnur og mikið járn í þessu sýni. Það sem er kristallað er svipað og í sýni #02. súlfíð og oxíð. Vottur af aragóníti og kalsíti er í þessu sýni.

#4 Hár bakgrunnur og tiltölulega mikið járn, tveir kristallaðir fasar, járnkarbónat, (siderít) [illegible]netít eða annað járnoxíð. Smávottur af KCl finnst í sýninu, einn toppur.

Reykjavík 21. maí 2002

Sigurður Sveinn Jónsson