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AEC RESEARCH AND DEVELOPMENT REPORT

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TOPICAL REPORT WIN-13

URANIUM RECOVERY BY HYDROGEN REDUCTION
OF CARBONATE LEACH LIQUORS

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ABSTRACT

The application of hydrogen reduction in the presence of a nickel catalyst for the recovery of uranium from carbonate liquors has been investigated. Tests were conducted on a laboratory scale in batch and continuous operations.

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INTRODUCTION

The recovery of uranium from carbonate liquors has been extensively investigated by J. Halpern¹⁻³ at the University of British Columbia. Halpern reported that uranium and vanadium could be precipitated from carbonate solutions (in what is believed to be a combined UO_2 and V_2O_3 precipitate) with gaseous hydrogen under pressures of 100 to 400 psig and temperatures of 120° to 150°C in the presence of a nickel catalyst. This method of precipitation is believed to have several advantages over the commonly used caustic precipitation. The barren liquors undergo no buildup in vanadium concentration, and the carbonate and bicarbonate are not destroyed.

A program was initiated to investigate the possible applications of hydrogen reduction to carbonate liquors derived from several ores under investigation at this Laboratory. Preliminary tests were made on Lukachukai, North Jackpile, and Todilto leach liquors using various contact times at constant hydrogen pressure and a nickel powder catalyst. The effectiveness of the nickel powder decreased upon recycling because of what appeared to be a buildup of precipitate on the powder. Because of this, and difficulty in separating the catalyst from the precipitate, nickel shot from 1/8 to 1/4 inch in size was tested. This form of catalyst proved to be effective and eliminated the need for magnetic separation.

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- 1/ Carnotite Ore Treatment Research Project, Progress Report Number 1, the University of British Columbia, April 1, 1952
  - 2/ Progress Report Number 2, August 1, 1952
  - 3/ Final Report, August 1, 1953

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

It has been found that uranium can be satisfactorily precipitated from carbonate leach solutions by reduction with hydrogen at elevated temperatures and pressures employing nickel shot as a catalyst.

The effect of the concentrations of sodium carbonate, sodium bicarbonate, vanadium, and molybdenum in the pregnant solution on the rate and degree of uranium precipitation was studied. Variation of sodium carbonate concentration from 12 to 70 grams per liter had little effect on uranium precipitation. Increasing the concentration of sodium bicarbonate decreases the rate of precipitation. However, the effect is not serious in the concentrations normally found in leach liquors. Molybdenum appears to have no effect on the precipitation of uranium. Vanadium, in concentrations exceeding 0.3 gram per liter, definitely retards uranium precipitation. Nevertheless, complete precipitation can be obtained if sufficient time is allowed. Molybdenum reports in the barren solution, but the vanadium reports in the precipitate along with the uranium.

The process appears to have some advantage over methods now in use to precipitate uranium from carbonate solutions in that the uranium is recovered without destruction of carbonate or bicarbonate. This should make for better control in leaching and, in some cases, should make possible a considerable saving in reagents.

In the small scale equipment used in testing the process, complete precipitation was never attained due to the fact that liquor held in piping and at the bottom of the column did not have sufficient contact with the catalyst. The diminutive scale of the operations did not permit recovery of enough precipitate from the nickel shot to determine the grade or nature of the product obtainable under various operating conditions.

It is recommended that a series of semi pilot plant tests be made in larger equipment from which data may be obtained to design full-scale pilot plant equipment. It would be desirable to install this unit at the Grand Junction Pilot Plant where adequate volumes of solution will be available.

APPARATUS

Three different equipment arrangements were used in this study of the hydrogen reduction procedure. The first was used in the preliminary study using nickel powder as a catalyst. This unit was a small, jacketed, autoclave equipped with a stirrer. The second unit consisted of an autoclave filled with nickel shot, and the original autoclave employed as a preheater. The third unit employed the same equipment as previously used, with the addition of a reservoir which permitted continuous flow through the reactor. The details of equipment construction are given below.

A. Autoclave with Stirrer (Nickel Powder Catalyst)

The apparatus used consisted of a jacketed autoclave with a stirrer which was driven by a 48 rpm gear-ratio-motor, a thermometer, a nitrogen cylinder (for flushing air), and a hydrogen cylinder with pressure regulating valve. The autoclave was heated by steam at 20 psig.

The autoclave, as shown in Figure 1, was made from a three-inch ID steel pipe, was 9 7/8 inches long, and flanged on top to permit sealing. Copper tubing was wound around the autoclave for steam heating and the unit was then lagged. Two, 1/4-inch holes were made in the autoclave, one for introduction of nitrogen and hydrogen and the other for a thermometer.

The stainless steel stirrer was chain-driven externally by a 1/4-horsepower, 48 rpm gear-ratio-motor. A four to one gear ratio was used, giving the stirrer 192 rpm. Garlock high pressure packing was used to keep the autoclave sealed. The head of the autoclave had to be removed for every loading and for removal of the solution.

B. Fixed Nickel-Bed Reactor

1. Batch Operation

The apparatus for this unit consisted of a jacketed, stainless steel autoclave 37 1/2 inches high and 1 1/4 inches ID, a preheater (the autoclave previously used, minus the stirring mechanism), two thermometers, two, 1/8-inch stainless steel needle valves, a 3/4-inch gate valve, a pressure gauge, nitrogen and hydrogen cylinders with pressure regulating valves, and 1/8-inch steel piping.

Figure 1. Apparatus for Precipitation with Hydrogen and Nickel Powder

The stainless steel autoclave, as shown in Figure 2, contained 5.9 pounds of minus three- plus four-mesh nickel shot which occupied 503 cc of the total volume of 754 cc. Steam, at 20 psig, entered the jacket of the autoclave (reactor) first and discharged into the jacket of the preheater. This arrangement maintained a constant temperature of 120°C in the reactor. The pregnant solution charge was put into the preheater through a 3/4-inch gate valve. The preheated solution was then forced over to the reactor with nitrogen pressure, which also served to flush the air out of the reactor at the same time. Hydrogen was introduced into the bottom of the reactor until the desired pressure was obtained and this pressure was maintained during the test. After the allotted time, the hydrogen was shut off and the bottom valve was opened. The gas pressure forced out all the barren liquor with the precipitate.

2. Continuous Operation

The apparatus used was the same as in the previous system (B.1.) except that a 16-liter tank for storage was connected to the preheater. Instead of using nitrogen, hydrogen was used both to force the solution into the preheater and to saturate the liquor with hydrogen.

The stainless steel autoclave, as shown in Figure 3, contained 9.1 pounds of minus three- plus four-mesh nickel shot, which filled the autoclave to the top. The void volume available for solution was 420 cc.

Figure 2. Apparatus for Batch Precipitation with Hydrogen and Nickel Shot

Figure 3. Apparatus for Continuous Precipitation

EXPERIMENTAL PROCEDURES

Procedure A. Autoclave with Stirrer (Powdered Nickel Catalyst)

A 500-ml charge was placed in the autoclave with the desired amount of nickel powder. The autoclave was sealed, flushed out with nitrogen, the steam turned on, and the solution allowed to reach a maximum temperature of 120° to 122°C. Then hydrogen was introduced until a pressure of 150 psig was obtained, and the stirrer was turned on. The stirrer, hydrogen, and steam were shut off after a prescribed time. The autoclave was allowed to cool, the head taken off, and the contents removed by vacuum. Then the nickel was separated from the solution by means of a small bar magnet, and the solution was filtered to separate the precipitate.

Procedure B. Fixed Nickel-Bed Reactor - Batch Operation

A charge of the desired volume was placed in the preheater and brought up to 120°C. Then the charge was forced into the autoclave with nitrogen gas. The excess pressure was released through a valve on the preheater, and the autoclave sealed by closing the valve on the entering line. Hydrogen was introduced at the bottom of the reactor, and the desired hydrogen pressure was maintained throughout the test. After an allotted time, the hydrogen was shut off, and the charge was removed by opening a valve at the bottom of the autoclave. The solution was filtered, and the filtrate submitted for analysis.

Procedure C. Fixed-Bed Reactor - Batch Operation

When using Procedure B it was found that the solution at the bottom of the autoclave was not reduced as effectively as the solution in the main body of the apparatus. Therefore, the overall grade of the barren liquor was slightly high. An attempt was made to overcome this effect by leaving 50 ml of the solution from the previous test in the autoclave. In this manner, the hydrogen in the autoclave was not discharged, and the solution remaining on the bottom of the autoclave for the next test was already reduced. The barren solution was submitted for uranium analysis, and the autoclave was again filled with the usual amount of pregnant solution for the next test.

Procedure D. Fixed-Bed Reactor - Continuous Process

The 16-liter storage tank was filled with pregnant solution and sealed. Hydrogen, at 300 psig pressure was admitted to

the bottom of the tank in order to force the solution over into the preheater. After the solution had reached 120°C, the valve entering the autoclave was opened, and hot solution filled the autoclave. A needle valve at the bottom of the reactor was opened to allow the solution to flow continuously through the reactor at the desired rate.

EXPERIMENTAL RESULTSProcedure A. Using Powdered Nickel Catalyst

Initial tests were made on the procedure using leach liquors from Lukachukai, Todilto, and North Jackpile ores in addition to an artificial solution containing only uranium, sodium carbonate, and sodium bicarbonate. The compositions of the liquors used are as follows:

<u>Leach Liquor</u>	<u>Assay, Grams/Liter</u>			
	<u>U₃O₈</u>	<u>V₂O₅</u>	<u>Na₂CO₃</u>	<u>NaHCO₃</u>
Lukachukai	1.42	0.43	52.0	20.0
Todilto	1.59	0.20	38.2	14.5
North Jackpile	1.03	0.018	46.0	6.7
Artificial	0.96	0.00	49.0	11.0

The results of experiments using this method of precipitation are given in Appendix A, Table I. Satisfactory results were obtained on all but Lukachukai solution, with precipitation of about 99 per cent of the uranium, as long as fresh nickel powder was used on each test. However, on recycling the catalyst, results became progressively poorer. Under the conditions used, complete precipitation could not be obtained from Lukachukai liquor. It will be noted that this solution is much higher in vanadium and bicarbonate content than the others tested.

Procedure B. Fixed-Bed Nickel Shot Reactor - Batch Operation

Of primary concern was the question of whether or not the surface of the nickel became passive upon continued reuse. Therefore, a series of 18 tests was run on a charge of 5.9 pounds of nickel shot. It was decided to use nickel shot for this work so that handling losses would be minimized. The pregnant solution used was an artificial solution containing 1.09 grams U₃O₈, 50 grams Na₂CO₃, and 11 grams NaHCO₃ per liter. A temperature of 122°C and pressure of 150 psig of hydrogen were used. Reaction times of 30, 60, and 90 minutes were employed to obtain a measure of precipitation rate. The following results were obtained:

Reaction Time, Minutes	30	60	90
Average Per Cent Precipitation	86.2	91.3	96.6

When the pressure was increased to 300 psig at a reaction time of 60 minutes, 93 per cent of the uranium was precipitated. No decrease in the efficiency of the nickel shot was noted during the series of tests.

The per cent precipitation was lower than expected, based on previous results using nickel powder. It was suspected that some of the solution in the bottom of the column and in the outlet piping might not be contacting the catalyst for sufficient time to become completely reduced. Therefore, a series of five tests was run using a retention time of 60 minutes and the effluent was removed from the reactor in three equal fractions. These fractions were assayed separately, and the following results were obtained.

<u>Fraction Number</u>	<u>1</u>	<u>2</u>	<u>3</u>
Average Per Cent Precipitation	92.0	99.2	99.5

The first fraction, which would be the solution in the bottom of the column, gave lower results than the solution above it.

Procedure C. Fixed-Bed Reactor - Batch Operation

In order to eliminate the difficulty encountered due to partial reduction of solution in the bottom of the reaction vessel, a change was made in the procedure. The autoclave was first charged with 200 ml of pregnant solution from the top. At the end of the precipitation period 150 ml were withdrawn, leaving 50 ml of reduced liquor in the bottom of the chamber. For each subsequent test, 150 ml of pregnant solution were admitted to the top of the chamber, and the same volume was withdrawn from the bottom. Operating in this manner, the uranium should be completely precipitated from the solution before it is drawn into the piping at the bottom of the reactor. In a series of tests, the following results were obtained.

<u>Hydrogen Pressure</u>	<u>Time, Minutes</u>	<u>Average % Precipitation in Fraction</u>			<u>Number of Tests</u>
		<u>1</u>	<u>2</u>	<u>3</u>	
300	60	95.0	99.5 ^{1/}	99.6	12
300	60	94.0	99.3 ^{1/}	--	13

^{1/} 100-ml fraction.

While this procedure produced some improvement, it did not entirely correct the situation. Either there was some mixing of

incoming solution with that remaining at the bottom of the reactor, or the precipitate has a tendency to redissolve upon being removed from the catalyst. In large-scale operation the effect of holdup in piping would be minimized. If necessary, a small amount of solution could be recycled.

A series of tests was run to determine the effect on the completeness of precipitation caused by variation in concentration of various salts in the pregnant solution.

For these tests the autoclave was charged with 200 ml of pregnant solution. The charge was held at a pressure of 300 psig and temperature of 120°C for varying times so that the rate of precipitation could be determined. At the end of the test the first 50 ml of slurry was drawn off and discarded. The remaining charge was then withdrawn from the reactor and filtered. The barren solution was analyzed to determine the percentage precipitation of the uranium. By this procedure it was possible to prevent the effect of unreduced solution in exit piping at the bottom of the reactor from masking the results of the individual tests.

In the first set of tests the Na_2CO_3 concentration of an artificial liquor was varied from 12 to 70 grams per liter, while the NaHCO_3 concentration was two to six grams per liter. The results of these tests are plotted in Figure 4, and detailed data are given in Appendix Table II. It may be seen from Figure 4 that large variations in sodium carbonate concentration produce very little effect on the rate or degree of uranium precipitation. In all tests, precipitation of better than 99 per cent of the uranium was achieved in less than 10 minutes.

In the second set of tests, the NaHCO_3 concentration of an artificial liquor was varied from 13 to 50 grams per liter while the Na_2CO_3 concentration was one to three grams per liter. The results are plotted in Figure 5. The data are given in Appendix Table III. Figure 5 shows that increasing the concentration of NaHCO_3 decreases the rate of uranium precipitation. Concentrations higher than 32 grams of NaHCO_3 per liter required more than 10 minutes to reach 99 per cent precipitation of the uranium.

In the third series of tests, the Na_2CO_3 concentration was held constant at approximately 50 grams of Na_2CO_3 per liter and the NaHCO_3 concentration was increased from 4.0 to 23.2 grams per liter. The results are plotted in Figure 6.

Figure 4. Effect of Na_2CO_3 Concentration on Rate of Uranium Precipitation

Figure 5. Effect of NaHCO_3 Concentration on Rate of Uranium Precipitation

Figure 6. Effect of NaHCO_3 in Solutions Containing 50 Grams of Na_2CO_3 Per Liter

Figure 6 again shows the harmful effect of increasing NaHCO_3 concentration on the rate of uranium precipitation. Appendix Table IV gives the data on this series of tests, and on a subsequent series in which concentrations of both carbonate and bicarbonate were varied together. The latter series indicates that a high concentration of both salts together has a marked deleterious effect on rate and degree of uranium precipitation.

Using the same test procedures, brief studies were made of the effect of molybdenum and vanadium in the leach liquor on the precipitation of uranium. The results of these tests are given in Appendix Tables V through IX. Molybdenum in concentrations up to 2.7 grams per liter, the highest concentration tested, had no effect on uranium precipitation. However, vanadium in concentrations exceeding 0.3 gram per liter definitely retards uranium precipitation. Nevertheless, if sufficient reaction time is given, complete precipitation can be obtained. Molybdenum remains in the barren solution, but the vanadium reports in the precipitate. Thus, on vanadium bearing solutions, an additional purification step would be required on the product.

Procedure D. Continuous Operation

A pressure cylinder was attached to the apparatus to permit continuous flow of solution through the preheater and reactor. The cylinder had a capacity of 16 liters. Hydrogen gas introduced into the bottom of this cylinder under pressure was used to force the liquor through the system, the flow rate being controlled by a valve on the outlet at the bottom of the reactor. The volume of solution held in the reactor during these tests was approximately 400 ml.

Artificial solutions containing about one gram of U_3O_8 per liter and varying proportions of vanadium, sodium carbonate, and sodium bicarbonate were passed through the reactor at retention times of nine to 30 minutes. The data obtained are given in the Appendix in Table X. The results were erratic on duplicate tests and it appeared that precipitate buildup in the bed of nickel shot caused some plugging and channeling of solution. The highest per cent precipitation was 98.8, obtained when using a retention time of 30 minutes on a liquor containing 1.2 grams U_3O_8 , 0.12 gram V_2O_5 , 43.7 grams Na_2CO_3 , and 11.5 grams NaHCO_3 per liter.

The uranium product obtained from the test series contained about 83 per cent U_3O_8 . It was a dull, black, sooty material

resembling finely ground coal. No crystalline forms were noted at a magnification of 60X. The filterability of the product was excellent.

At the end of the tests the 9.1 pounds of nickel shot used in the reactor showed no loss in weight. The surface of the metal was still smooth, with no evidence of pitting or corrosion. No trace of nickel could be found in the precipitate or barren solutions. The indications are that the nickel catalyst should last indefinitely. The difficulties encountered in continuous operation probably can be overcome by provision for some type of mild agitation. This could be obtained by introducing hydrogen gas into the bottom of the reactor instead of the top, or by using a pulsating type of feed pump.

APPENDIX ATable IResults Using Nickel PowderLeach Liquor From Ores:

<u>Liquor</u>	<u>Time, Minutes</u>	<u>Nickel Grams/Liter</u>		<u>% Ppt'n</u>
		<u>Fresh</u>	<u>Recycle</u>	
Lukachukai-Sample 17-10	70	10		45.0
	110	10		67.6
	180	10		93.5
	110		10	76.0
	180		10	72.5
	240		10	67.6
	120		10	None
Todilto Limestone-Sample 93-2	120	10		99.1
	180	10		99.0
	240	10		99.3
North Jackpile-Sample 77-3	60	10		99.0
	120	10		99.0
	180	10		99.0
	120	4		98.6
	120		4	95.8
	120		4	93.9
Artificial	60	10		98.6
	60		10	98.8
	120		10	97.4
	60		10	97.3
	60	5		98.6
	30		5	98.0
	60		5	98.4

Table IIEffect of Sodium Carbonate Concentration on Uranium Precipitation

<u>Grams/Liter</u>			<u>% Precipitation in Indicated Time in Minutes</u>					
<u>U₃O₈</u>	<u>Na₂CO₃</u>	<u>NaHCO₃</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>10</u>	<u>15</u>	<u>20</u>
1.05	12.3	2.2	98.7	98.7	99.3	99.4	99.5	
1.05	20.6	4.6	97.9	98.6	98.7	99.5	99.5	
0.98	29.5	6.4	98.4	98.9	99.0	99.4	99.4	
1.00	40.3	3.8	98.2		98.8	99.1	99.1	
1.15	50.0	3.9	98.9		98.5	98.8	99.3	
1.00	60.4	1.7				99.1	99.3	99.3
0.99	70.3	3.6				99.0	99.0	99.0

Table IIIEffect of Sodium Bicarbonate Concentration on Uranium Precipitation

<u>Grams/Liter</u>			<u>% Precipitation in Indicated Time in Minutes</u>							
<u>U₃O₈</u>	<u>Na₂CO₃</u>	<u>NaHCO₃</u>	<u>1/2</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>10</u>	<u>15</u>
0.92	1.0	13.2				98.6		99.3	99.4	99.4
0.95	1.6	22.1	75.7	96.0	97.9	98.3	98.6	99.3	99.3	99.4
0.96	2.0	31.6		83.3		97.3	97.3	98.5	99.0	
0.96	2.7	38.1						95.5	98.7	99.3
1.30	3.2	48.0						92.0	96.8	98.3

Table IV

Effect of Sodium Bicarbonate on Rate of Uranium
Precipitation From Solutions Containing
High Concentrations of Sodium Carbonate

<u>Grams/Liter</u>			<u>% Precipitation in Indicated Time in Minutes</u>						
<u>U₃O₈</u>	<u>Na₂CO₃</u>	<u>NaHCO₃</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>10</u>	<u>15</u>	<u>20</u>	<u>30</u>
1.15	50.0	3.9	98.9		98.5	98.8	99.3		
1.01	51.4	12.4			96.2	98.0	98.6	99.2	
1.13	51.7	23.2			83.5	95.6	97.2	97.4	
0.95	10.6	14.8	94.0	98.3	98.7	99.2	99.3		
0.91	21.5	23.5			95.0	98.7	99.0		
0.94	31.3	33.5				87.2	94.1	95.2	
1.04	41.3	44.5					64.0	71.0	80.8

Table V

Effect of Vanadium and Molybdenum

<u>Grams/Liter</u>					<u>% Precipitation in Indicated Time in Minutes</u>					
<u>U₃O₈</u>	<u>V₂O₅</u>	<u>Mo</u>	<u>Na₂CO₃</u>	<u>NaHCO₃</u>	<u>10</u>	<u>15</u>	<u>30</u>	<u>60</u>	<u>90</u>	<u>120</u>
1.36			63.0	22.5		89.0	92.7	95.5		
1.27	0.32		62.6	22.5	54.3		80.0	87.4		92.6
1.27		0.15	62.1	23.7		94.7	96.1	98.0		
1.36	0.36	0.15	64.0	22.8			75.0		89.7	94.3

Table VI

Effect of Vanadium with Low Na₂CO₃ and NaHCO₃ Concentrations

<u>Number of Tests</u>	<u>Grams/Liter</u>				<u>Time, Minutes</u>	<u>Average % Ppt'n</u>
	<u>U₃O₈</u>	<u>V₂O₅</u>	<u>Na₂CO₃</u>	<u>NaHCO₃</u>		
7	1.17	0.06	1.0	2.2	15	99.4
7	1.14	0.12	0.77	2.0	15	99.4
7	1.13	0.22	0.59	2.4	15	99.1
8	1.15	0.33	0.27	2.7	15	99.1

Table VIIEffect of Vanadium at Higher Na₂CO₃ and NaHCO₃ Concentrations

Number of Tests	Grams/Liter				Time, Minutes	Average % Ppt'n
	U ₃ O ₈	V ₂ O ₅	Na ₂ CO ₃	NaHCO ₃		
5	1.04	0.00	20.0	10.0	15	98.0
7	0.99	0.10	21.0	10.0	15	99.3
7	1.15	0.34	12.2	18.9	15	99.1
7	1.18	0.43	11.8	19.6	15	81.4
4	1.01	0.49	22.3	9.4	15	92.8
7	1.15	0.59	11.6	19.9	15	56.5

Table VIIIEffect of High Vanadium Concentrations

Number of Tests	Grams/Liter				% Precipitation in Indicated Time in Minutes			
	U ₃ O ₈	V ₂ O ₅	Na ₂ CO ₃	NaHCO ₃	30	45	60	90
2	1.01	0.49	22.3	9.4	96.8		98.7	
3	1.03	1.02	22.8	9.1		97.8	98.3	99.05

Table IXEffect of Molybdenum on Precipitation

Number of Tests	Grams/Liter					Time, Minutes	Average % Ppt'n
	U ₃ O ₈	V ₂ O ₅	Na ₂ CO ₃	NaHCO ₃	Mo		
9	1.20	0.1	10	20	1.53	15	99.6
9	1.05	0.1	10	20	2.70	15	99.3

Table XContinuous Operation

<u>Grams/Liter in Feed</u>				<u>Retention Time, Minutes</u>	<u>Volume Liters</u>	<u>% Ppt'n</u>
<u>U₃O₈</u>	<u>V₂O₅</u>	<u>Na₂CO₃</u>	<u>NaHCO₃</u>			
1.10	0.072	49.9	14.9	28.4	12.0	95.1
0.99	--	40.2	14.5	19.2	13.5	98.1
0.90	0.14	63.4	3.2	15.1	11.0	95.9
0.99	0.15	59.4	7.5	9.1	3.8	77.0
				14.3	5.0	90.0
				21.8	5.5	92.8
1.40	0.15	54.2	10.9	17.6	7.0	80.0
				20.8	6.2	87.0
1.20	0.12	43.7	11.5	14.3	--	93.0
				18.2	--	95.0
				28.6	--	98.8
1.10	0.18	47.8	8.95	21.0	7.0	84.5
				21.0	1.1	97.0
				22.2	1.5	91.5
				23.5	3.0	97.2
0.96	0.08	45.0	8.77	12.9	6.5	93.7
				21.0	4.0	97.7