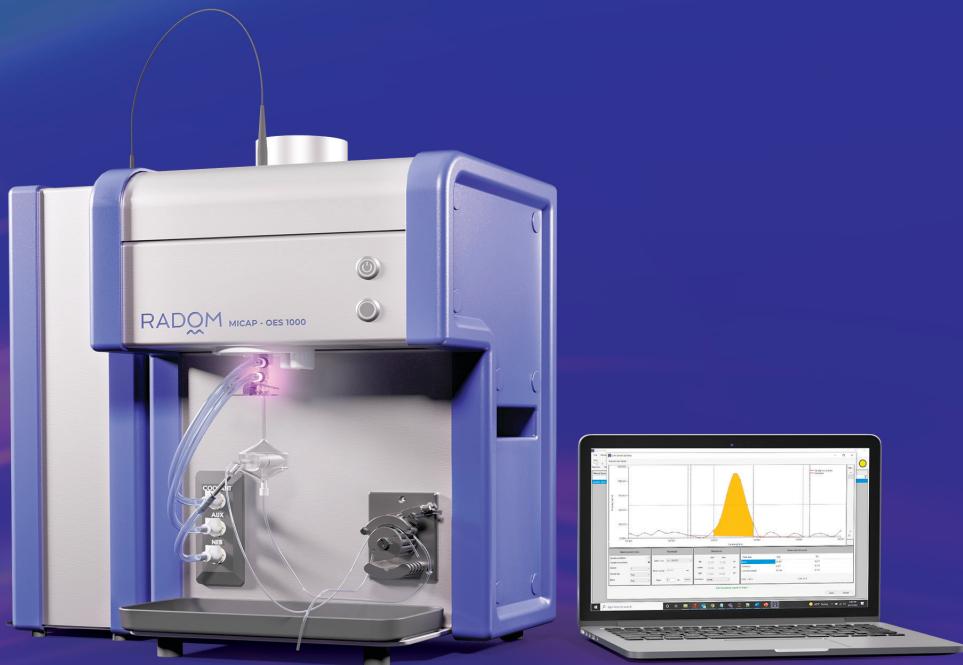


# MICAP-OES 1000

**Microwave Inductively Coupled Atmospheric Plasma  
Optical Emission Spectrometer**



- Lowest Operating Cost
- Simultaneous Measurement
- Robust N<sub>2</sub> ICP with Cerawave™
- Smallest Laboratory Footprint

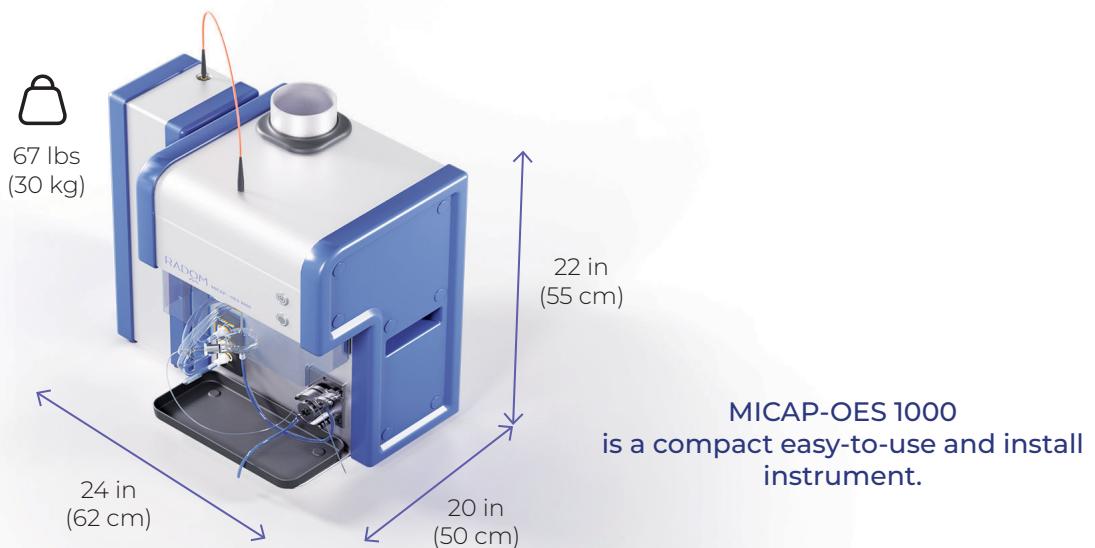


Figure 1: MICAP-OES 1000 Dimensions. Small, light-weight design made possible by Cerawave

Radom Instruments developed the solution for onsite instrumentation with Microwave Inductively Coupled Atmospheric Plasma – Optical Emission Spectrometer with 1000W power. This innovative nitrogen-based plasma atomic spectroscopy instrument replaces the traditional argon generated plasma technology.

MICAP-OES 1000 uses highly efficient Cerawave technology which eliminates the electric water-cooled coil found in commercially available ICP-OES

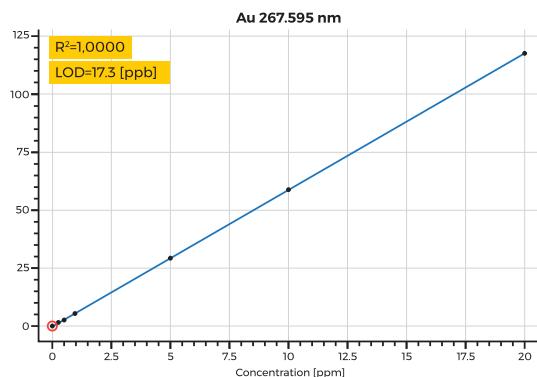
instruments today. Cerawave does not need water or air cooling and nitrogen is less expensive than argon. The power of Cerawave technology, coupled with a high-resolution echelle polychromator with CMOS detector, provides simultaneous measurement of elements in the prepared sample. The ability to screen core samples on location means results can be determined more quickly. An added benefit is the ability to collect more samples in an area to create a comprehensive map of the potential yield.

**Table 1. Sample Introduction Area (SIA)**

Autosampler	Teledyne Cetac Technologies ASX-560
Sample Tubing	Black/black PVC 0.76 mm ID
Drain Tubing	Yellow/blue PVC 1.52 mm ID
Nebulizer	Low-flow quartz nebulizer 1.0 mL/min
Spray chamber	Single pass cyclonic
Torch	20 mm quartz torch with 1.5 mm injector



Figure 2: Torch installation assembly



Typical calibration curve for gold (wavelength 267.595 nm) standardized from 0.025 ppm to 20 ppm displays the correlation coefficient as R2 and the calculated LOD.

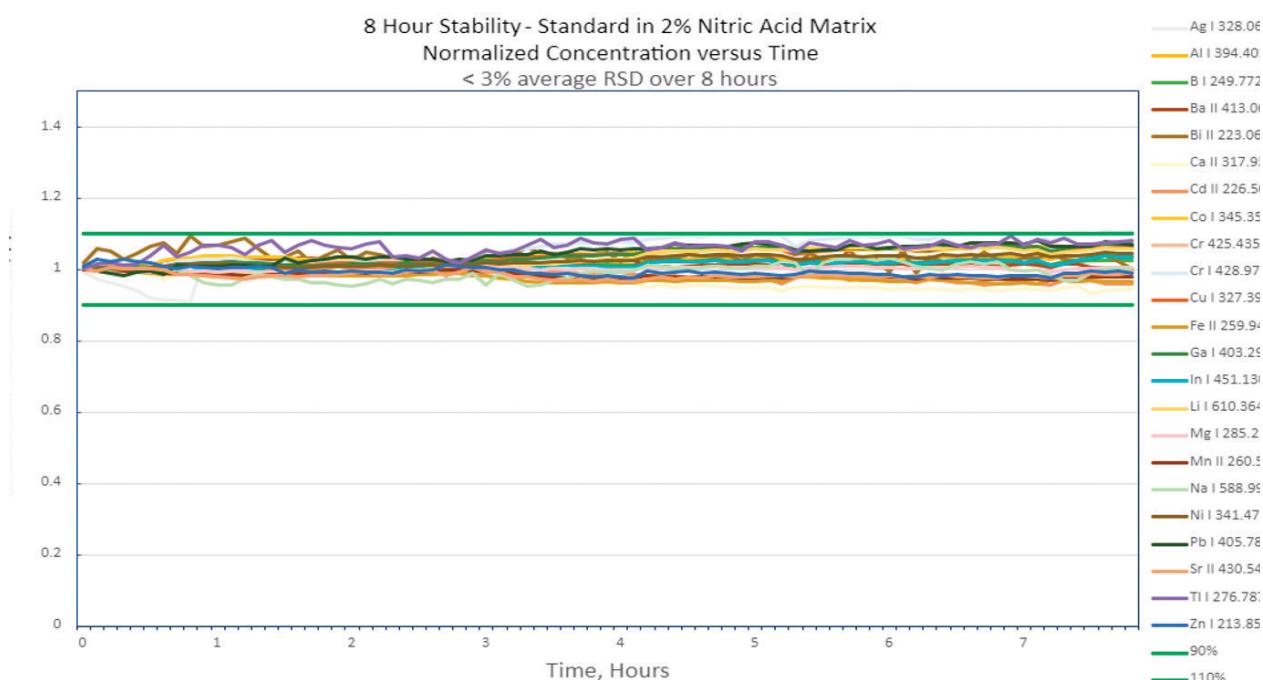
## Results and Discussion

The CRM ID listed in the Table 2 summary provides certified results for gold based on statistical results submitted from participating laboratories. The certificate provides gold certification with preparation of ore by Pb (lead) fire assay, 4-acid digestion, aqua regia and cyanide leach. The study performed with MICAP-OES 1000 was aqua regia preparation only. According to the certificates, the aqua regia digestion participants use ICP-OES, ICP-MS and AAS to report the gold values in the ore.

The CRMs were prepared in duplicate and no additional dilution was required from the digested preparation of 2g to 50mL.

**Table 2. OREAS CRM Results for Gold in Aqua Regia Digestions**

Analyte	Wavelength	CRM ID	Certified Value	Preparation 1	Preparation 2	Dilution	Recovery1	Recovery2
Au, ppm	267.595	238	2.95	2.99	2.84	1x	101%	96%
		242	8.33	6.95	7.28	1x	83%	87%
		255b	4.08	3.82	3.77	1x	94%	92%
		256b	7.58	7.61	7.13	1x	100%	94%
		257b	14.17	14.55	15.42	1x	103%	109%





# MICAP-OES

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## vs. ICP-OES

### NEW POSSIBILITIES

- Powered by proprietary Cerawave technology
- Smallest and lightest instrument on the market
- Easy set up (box-to-bench in less than one hour!)
- Works with local nitrogen generation
- Lower service maintenance
- Higher operational efficiency
- Lower ownership cost (pays for itself in less than 3 years!)
- Lower carbon footprint

### SERVICE MAINTENANCE ADVANTAGE

-  No maintenance required for RF generators/coils, detector or optical alignment, chiller malfunction (overheating or not in well-ventilated area)  
– MICAP does not have these!
-  Simple, easy maintenance by end-user of peristaltic pump and fiber optic connection – no more waiting for service engineers!
-  2 year warranty vs. typical 1 year warranty
-  Service Package -1st year includes user replaceable components (peristaltic pump, fiber optic cable, collimator, and second Starter Kit)

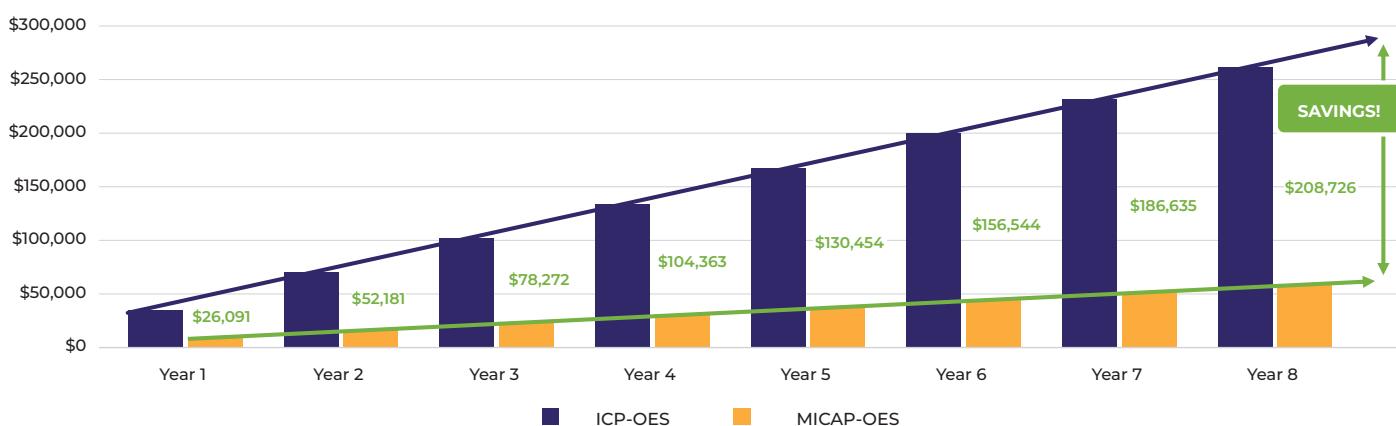
{ It's better for your lab  
and for the environment! }

## ANNUAL OWNERSHIP COST

	ICP-OES	MICAP-OES
Year 1	\$109,836	\$82,067
Year 2	\$33,336	\$7,067
Year 3	\$33,336	\$7,067
<b>Total cost:</b>	<b>\$176,508</b>	<b>\$96,200</b>
<b>Cost savings:</b>		<b>\$80,308</b>

3-year total cumulative cost savings of \$80,308 over traditional ICP-OES!

## CUMULATIVE COST SAVINGS



Total cumulative cost savings of \$208,726 over argon-based ICP-OES!



## LIFETIME CO<sub>2</sub>e EMISSIONS SAVINGS COMPARED TO ARGON-BASED INSTRUMENTS

kWh saved	1,772,540
Metric tons of CO <sub>2</sub> e saved*	1,256

Equivalent to:

	Homes' annual electricity use	244
	Gasoline-powered passenger vehicles	280
	Total gallons of gasoline consumed	141,357
	Total smartphones charged	152,812,225

\*Based on 8-year useful-life. Source: EPA.GOV  
(<https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator>.)

MICAP-OES 1000 saves 1,256 Metric tons of CO<sub>2</sub>e over 8 years. It has the lowest carbon footprint of any OES instrument in the market!

RADOM MICAP - OES 1000

## MICAP-OES

### VS. FLAME ATOMIC ABSORPTION



#### FASTER AND SIMPLER ANALYSIS



Safer - eliminates the need for combustible gases and potential for flashback



No optimization of fuel/oxidant ratios, burner height or rotation which can be subjective to individual users



Simultaneous elemental measurements in less than 3 minutes/sample (3 replicates)



Full wavelength spectrum analysis and simultaneous measurement



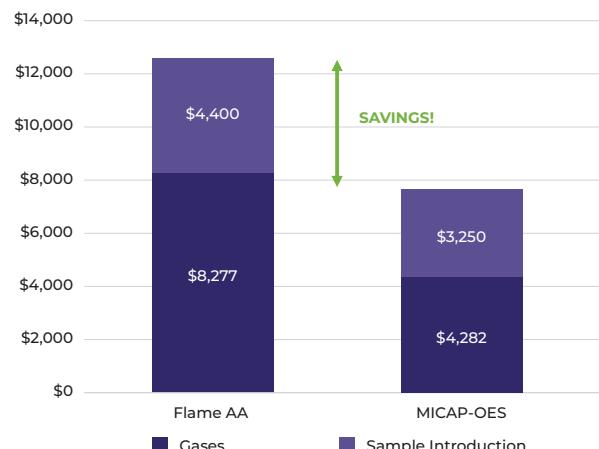
Library of emission lines for minimization of interferences and result confirmation



Less sample preparation, less chemistry, and less consumables required

Analysis Time Considerations	Flame AA	MICAP-OES
Number of elements	7	7
Number of solutions	35	35
Time per sample analysis for 3 replicates	40 sec	2.3 minutes
Burner/fuel/lamp optimization and warmup time	30 min	20 min
Time per sample analysis for 3 replicates	20 min	20 min
Preparation time (6 elements)	2 hr	-
Instrument setup/warmup time (6 elements)	3 hr	-
Analysis time (6 elements)	3 hr	2 hr
<b>Total</b>	<b>8 hr</b>	<b>2 hr</b>

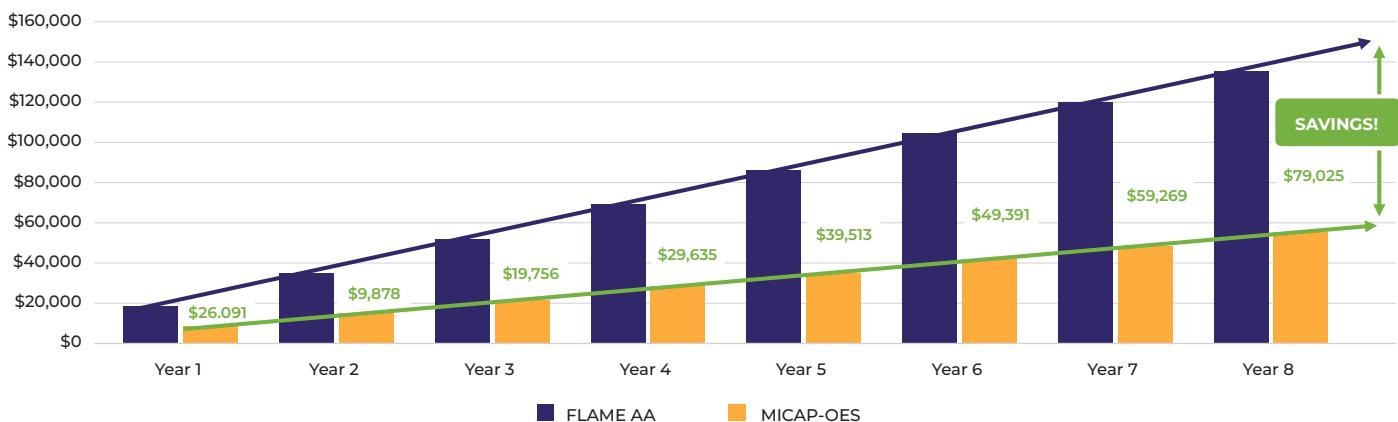
## ANNUAL CONSUMABLE COST COMPARISON



**MICAP-OES 1000 is  
4x faster than Flame AA!**

**MICAP-OES 1000 saves \$5,100  
per year on consumables!**

## CUMULATIVE COST SAVINGS



**Total cumulative cost savings of \$79,025 over traditional Flame AA!**

“ MICAP-OES is a logical replacement to the many AA systems, existing MP-AES systems and even many ICP-OES systems in harsh mining environments. ”

– Major Gold Mining Company User, US

“ I can see the MICAP-OES system used on oil platforms. ”

– Danish Offshore Technology Centre

“ Cerawave improves plasma robustness ... improves detection capabilities. ”

– Alicante University, Spain

“ Laser ablation on the front of this OES instrument is likely a good solution for mine solid sampling in the field. ”

– University of Gothenburg, Sweden

# MICAP-OES 1000

## Typical Limit of Detection and Resolution

Key		Typical Resolution									
		Wavelength (nm)					Resolution (pm)				
1	H	2	▼				Zn 202.584	5	13	14	▼
	HYDROGEN						Cr 360.534	11			
2	Li	4	234.66nm	8 ppb	CHROMIUM		Ba 455.403	14			
	LITHIUM						Na 588.996	21			
3	Be	3	610.564nm	19 ppb	BERYLLIUM		Li 610.364	30			
	LITHIUM										
4	Mg	12	279.553nm	1 ppb	MAGNESIUM						
	SODIUM										
5	Na	11	588.959nm	2 ppb	SODIUM						
6	K	19	756.949nm	24 ppb	POTASSIUM						
	RUBIDIUM										
7	Rb	37	393.566nm	7 ppb	CAESIUM						
8	Sc	21	361.528nm	1 ppb	SCANDIUM						
	TITANIUM										
9	Cr	23	311.077nm	9 ppb	VANADIUM						
10	Mn	24	248.973nm	8 ppb	CHROMIUM						
11	Fe	26	259.404nm	12 ppb	IRON						
12	Ni	28	346.165nm	27 ppb	NICKEL						
13	Cu	29	324.754nm	2 ppb	COPPER						
14	Co	30	213.057nm	26 ppb	ZINC						
15	Al	31	403.298nm	11 ppb	GALIUM						
	ALUMINUM										
16	Si	32	265.171nm	14 ppb	SILICON						
17	P	33	238.812nm	500 ppb	PHOSPHORUS						
18	Cl	34	198.026nm	50 ppb	CHLORINE						
19	Br	35	149.000nm	790 ppb	SELENIUM						
20	Ar	36	104.000nm	310 ppb	ARSENIC						
21	Kr	37	94.000nm	74 ppb	BROMINE						
22	Xe	38	83.163nm	230 ppb	KRYPTON						
23	Ti	39	73.940nm	13 ppb	TI						
24	Sc	40	63.940nm	10 ppb	TIANIUM						
25	Cr	41	53.079nm	47 ppb	NIKEL						
26	Mn	42	47.932nm	22 ppb	MANGANESE						
27	Fe	43	44.793nm	12 ppb	MOLODENIUM						
28	Co	44	37.089nm	8 ppb	PALLADIUM						
29	Ni	45	36.926nm	10 ppb	RHODIUM						
30	Zn	46	36.595nm	16 ppb	PTALIUM						
31	Ga	47	32.983nm	13 ppb	AG						
32	Ge	48	30.915nm	10 ppb	CDMIUM						
33	As	49	28.832nm	94 ppb	INIDIUM						
34	Sb	50	26.915nm	110 ppb	INDIUM						
35	Te	51	25.853nm	74 ppb	ANTIMONY						
36	I	52	23.879nm	83 ppb	TELIURUM						
37	Y	53	20.616nm	14,000 ppb	IODINE						
38	Nb	54	19.915nm	1 ppb	XENON						
39	Zr	55	19.764nm	37 ppb	RADON						
40	Tc	56	19.645nm	34 ppb	ASTATINE						
41	Mo	57	19.527nm	16 ppb	POLOMUM						
42	Ru	58	19.415nm	84 ppb	THALLIUM						
43	Ta	59	19.317nm	39 ppb	FRONTIUM						
44	Hf	60	19.215nm	40 ppb	DARMSTADTUM						
45	W	61	19.115nm	43 ppb	MEITNERIUM						
46	Re	62	19.015nm	109 ppb	SEABORGIUM						
47	Db	63	18.915nm	107 ppb	BOHRIUM						
48	Rf	64	18.815nm	106 ppb	DUBNIUM						
49	Bh	65	18.715nm	60 ppb	MEITNERIUM						
50	Sg	66	18.615nm	7 ppb	PROMETHIUM						
51	Bh	67	18.515nm	12 ppb	SAMARIUM						
52	Bk	68	18.415nm	19 ppb	TERBIUM						
53	Cf	69	18.315nm	4 ppb	DYSPROSIUM						
54	Am	70	18.215nm	67 ppb	HOBLIUM						
55	Ba	71	18.115nm	3 ppb	ERBIIUM						
56	Fr	72	18.015nm	1 ppb	THULIUM						
57	La	73	17.915nm	1 ppb	YTTERBIUM						
58	Ce	74	17.815nm	1 ppb	THULIUM						
59	Pr	75	17.715nm	1 ppb	YTTRIUM						
60	Nd	76	17.615nm	1 ppb	NEODYMIUM						
61	Pm	77	17.515nm	1 ppb	PRASEODIUM						
62	Sm	78	17.415nm	1 ppb	SAMARIUM						
63	Eu	79	17.315nm	1 ppb	EUROPIUM						
64	Gd	80	17.215nm	1 ppb	GYDROGENIUM						
65	Tb	81	17.115nm	1 ppb	TERBIUM						
66	Dy	82	17.015nm	4 ppb	DISPROSIIUM						
67	Ho	83	16.915nm	4 ppb	HOBLIUM						
68	Er	84	16.815nm	3 ppb	ERBIIUM						
69	Tm	85	16.715nm	2 ppb	THULIUM						
70	Yb	86	16.615nm	1 ppb	YTTERBIUM						
71	Lu	87	16.515nm	1 ppb	LUTETIUM						
72	Og	88	16.415nm	1 ppb	OGANESSIAN						
73	Fr	89	16.315nm	1 ppb	FRANCIUM						
74	Ac	90	16.215nm	1 ppb	ACTINIUM						
75	La	91	16.115nm	1 ppb	CELIUM						
76	Ce	92	16.015nm	1 ppb	PRASEODIUM						
77	Pr	93	15.915nm	1 ppb	SAMARIUM						
78	Nd	94	15.815nm	1 ppb	EUROPIUM						
79	Pm	95	15.715nm	1 ppb	GYDROGENIUM						
80	Sm	96	15.615nm	1 ppb	TERBIUM						
81	Eu	97	15.515nm	1 ppb	DISPROSIIUM						
82	Gd	98	15.415nm	1 ppb	HO						