

Tutorial of Sphalerite Classifier

Introductions to this tutorial

This document is a tutorial for the "Sphalerite classifier. xlsm" macro program. This program can be downloaded at [https://sdeakii.github.io/machine-learning/.](https://sdeakii.github.io/machine-learning/)

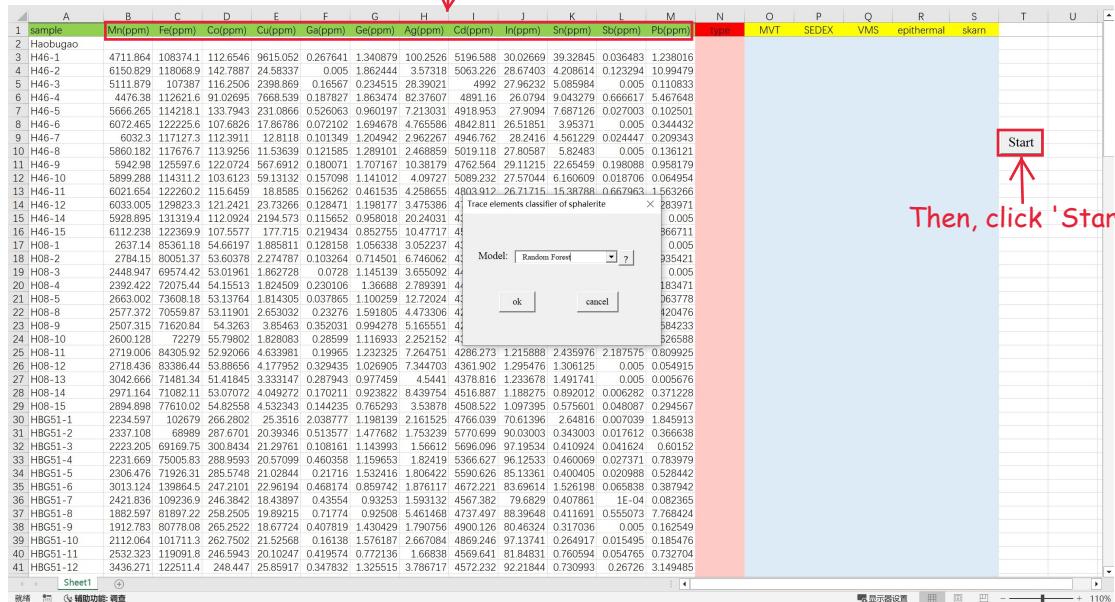
The sphalerite classifier is a classifier trained on multiple machine learning algorithms to predict the type of mineral deposit based on the trace element composition of sphalerite. This program facilitates deposit genesis identification on computers lacking a machine learning environment.

It is best to use Excel versions 2019 and above for this program, as there may be compatibility issues with older versions of Excel.

Steps:

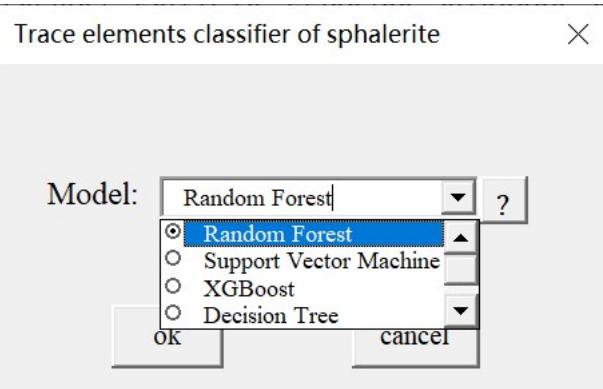
- (1) Fill in your element data of sphalerites in the order of the table, ensuring that your data corresponds one-to-one with the table elements. Then click the 'Start' button.

First, make sure your data corresponds one-to-one with the table elements.



Sample	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
		Mn(ppm)	Fe(ppm)	Co(ppm)	Cu(ppm)	Ga(ppm)	Ge(ppm)	Ag(ppm)	Cd(ppm)	In(ppm)	Sn(ppm)	Bi(ppm)	Pb(ppm)	Type	MVT	SEDEX	VMS	epithermal	skarn		
1	Sample	471864	1063741	1126546	9615052	0.267641	1.340879	100.2526	5196586	30.02669	39.32845	0.036483	1.298016								
2	Haobugao	6150.029	110808.9	142.7837	24.50331	0.095	1.892444	3.37318	5063.225	28.67403	4.208614	0.123244	0.99478								
3	H46-1	5111.873	107387	118.2508	2388.869	0.16957	0.24515	5.2021	1.0992	28.0523	5.038584	0.005	0.119833								
4	H46-2	4476.58	112621.6	91.02695	1668.539	0.187027	1.863474	82.37607	489.116	26.0784	9.043279	0.065017	5.467648								
5	H46-3	5666.265	114218.1	113.7943	231.0066	0.526063	0.96197	7.213031	4918.953	27.9094	1.687126	0.027003	0.102501								
6	H46-4	6072.465	122256.6	107.6826	17.86788	0.072102	1.694678	4.765586	4842.811	26.61851	3.05371	0.005	0.344432								
7	H46-5	6023.3	117127.3	11.8118	0.101349	1.204943	0.263267	4946.762	38.2416	4.561238	0.024447	0.029342									
8	H46-6	5860.182	117676.7	11.9256	11.5369	0.121585	1.289101	2.468859	5019.118	27.80587	5.82483	0.005	0.136121								
9	H46-7	5942.98	125597.6	12.2.0724	56.76912	0.180071	1.707167	10.38179	4762.564	11.2115	22.65459	0.018088	0.958179								
10	H46-8	5899.288	114311.2	103.6123	59.13132	0.157098	1.141012	10.23727	5089.232	27.57044	6.160609	0.018706	0.064954								
11	H46-9	6021.654	122260.2	115.645	18.8585	0.156262	0.461535	4.258655	4803.912	26.71215	15.38788	0.667963	1.563266								
12	H46-10	6033.005	129823.3	121.4241	23.73266	0.128471	1.98177	3.475386	4] Trace elements classifier of sphalerite					×	283971						
13	H46-11	5928.895	131319.4	112.0924	2194.573	0.115652	0.958018	20.42031	4] ok					0.005							
14	H46-12	6112.238	122369.9	107.5577	177.715	0.219434	0.852758	10.47717	4] cancel					866711							
15	H46-13	2637.14	85361.18	54.66107	1.885811	0.128158	1.056338	0.352237	4] Model: Random Forest	?				0.005							
16	H46-14	6000.128	72279	55.79802	1828083	0.28599	1.116933	2.252152	4] 278415	80051.37	53.60378	0.103264	0.714501	6.746062	4]	Random Forest	?	ok	cancel	395421	
17	H08-1	2608.12	719.004	84305.92	52.92066	4.633981	0.19965	1.232325	7.264751	4286.273	1.215888	2.435976	2.187575	0.809925							
18	H08-2	2718.434	83386.44	53.86684	4.177952	0.329435	1.026915	7.3403	4961.905	1.295476	1.306125	0.005	0.054915								
19	H08-3	3062.481	71481.34	50.1845	3.333183	0.281403	0.977453	4.546168	4.37816	1.23678	1.2474	0.005	0.049776								
20	H08-4	2392.422	72075.44	54.15513	1.824509	0.230106	1.36688	2.789391	4] ok					183471							
21	H08-5	2663.002	73608.18	53.13764	1814305	0.037865	1.100259	12.72024	4] cancel					637778							
22	H08-6	2507.372	71620.84	54.3263	3.85463	0.352031	0.994278	5.165551	4] 20476					584233							
23	H08-7	2600.128	72279	55.79802	1828083	0.28599	1.116933	2.252152	4] 2322.209	69169.75	300.8434	21.29761	1.142993	1.56612	5.696.094	0.971934	0.410923	0.041624	0.60152	3.71278	
24	H08-8	2608.898	77610.02	1026579	26.66202	25.3516	2.023877	1.198139	2.161525	4766.039	70.61396	2.64816	0.007039	1.845913							
25	H08-9	2234.507	71930.72	54.82558	4.532343	0.144235	0.765295	3.38078	4606.522	1.097595	0.575601	0.048087	0.294567								
26	H08-10	2337.108	68989	287.6701	20.38346	0.513577	1.477682	1.753239	570.699	90.03003	0.343003	0.0017612	0.366638								
27	H08-11	2222.209	69169.75	300.8434	21.29761	1.142993	1.56612	5.696.094	0.971934	0.410923	0.041624	0.60152									
28	H08-12	2231.666	75005.83	388.9593	20.57099	0.460358	1.159653	1.82419	5.366.627	96.12533	0.460065	0.027371	0.783979								
29	H08-13	2306.472	71926.31	285.5748	2.02844	0.21716	1.532416	1.806422	5590.626	85.13261	0.404040	0.02088	0.528442								
30	H08-14	3013.124	139864.5	247.2101	22.96194	0.488174	0.859742	1.876117	4672.221	83.69614	1.526198	0.065838	0.387942								
31	H08-15	2421.836	109236.9	246.3842	18.43897	0.43554	0.93253	1.593132	4567.382	4737.497	88.39648	0.411691	0.055073	7.768424							
32	H08-16	1882.597	81897.22	258.2505	18.89215	0.43554	0.92508	5.461468	4737.497	88.39648	0.411691	0.055073	7.768424								
33	H08-17	1912.783	80778.06	265.2522	18.67724	0.407819	1.430429	1.79076	4900.126	80.46324	0.317036	0.005	0.162549								
34	H08-18	2112.064	101714.3	262.7502	21.52568	0.16138	1.576187	2.667084	4869.246	97.13741	0.264917	0.015495	0.185476								
35	H08-19	2532.323	119091.8	246.5943	20.10247	0.419574	0.772136	1.66838	4569.641	81.84831	0.76059	0.054765	0.732704								
36	H08-20	3436.271	122511.4	248.447	25.85917	0.347832	1.325515	3.786717	4572.233	92.21844	0.730993	0.26726	3.149485								

Then, click 'Start'.



(3) Then this program will pop up a data selection interface, long press the left mouse button to select the data you want to classify. Then

click 'OK'.

Sample	Mn(ppm)	Fe(ppm)	Ce(ppm)	Cu(ppm)	Ga(ppm)	Ge(ppm)	Ag(ppm)	Cd(ppm)	In(ppm)	Sn(ppm)	Sb(ppm)	Pb(ppm)	type	MVT	SEDEX	VMS	epithermal	skarn	T	U
Haibugao																				
H46-1	4711.864	108374.1	112.6546	9615.052	0.267641	1.340979	100.3526	5106.580	30.02669	39.32845	0.036483	1.238016								
H46-2	6150.829	118068.9	142.7897	24.58237	0.005	1.862444	35.7318	5063.226	28.67403	4.209614	0.123294	10.99479								
H46-3	5111.879	107387	116.2506	2398.860	0.16567	0.234515	28.39021	4992	27.96232	5.095984	0.005	0.110833								
H46-4	4763.38	112621.6	0.102695	7668.539	0.187827	1.863474	82.37607	4801.16	26.0704	0.042329	0.666617	5.467648								
H46-5	5666.265	114218.1	133.7943	231.0966	0.526063	0.960197	7.213031	4918.953	27.9094	7.687126	0.027003	1.02501								
H46-6	6072.465	122225.6	107.6828	17.86786	0.072102	1.694678	4.765586	4842.811	26.51851	3.95371	0.005	0.344432								
H46-7	6032.3	117127.3	112.3911	12.8118	0.101349	1.204942	2.962267	4946.762	28.2416	4.561229	0.024447	0.209343								
H46-8	5860.182	117676.7	113.9295	11.53639	0.12158	1.289101	2.468859	5019.118	27.80587	5.82483	0.005	0.136121								
H46-9	5942.98	125597.6	122.0724	56.76912	0.180071	1.707167	10.38179	4762.564	29.11215	22.65459	0.198088	0.958179								
H46-10	5099.285	114311.2	103.6123	59.13132	0.157098	1.141012	4.09722	5089.232	27.57044	6.160609	0.018706	0.064954								
H46-11	6021.654	122260.2	115.6469	18.8585	0.156262	0.461538	4.258655	4803.912	26.71715	15.38788	0.667963	1.563266								
H46-12	6033.005	129823.3	121.2421	23.73266	0.128471	1.98177	4.375386	4719.162	26.88727	14.80751	0.111493	0.283971								
H46-13	5928.895	131319.4	112.0924	2194.573	0.115562	0.958018	20.24031	4393.862	24.11032	4.26128	0.059527	0.005								
H46-14	6112.238	122369.9	107.5577	177.715	0.219434	0.852755	10.47711	4540.736	24.756	6.635365	0.026838	0.866711								
H46-15	2637.14	85361.18	54.66197	18.85811	0.128158	10.56538	0.552237	4323.244	1.365546	0.932662	0.005	0.005								
H46-16	2784.45	80051.37	53.03037	22.747478	0.10326	4.674606	4.392144	1.291927	0.897512	0.023391	0.935421									
H46-17	2448.947	69574.42	53.01961	18.62728	0.0728	1.145139	6.355092	4482.302	1.543903	0.964472	0.005	0.005								
H46-18	2392.427	72075.44	1824509	2.901016	0.23016	1.36688	2.789393	4438.295	1.29700	0.966788	0.010783	0.183471								
H46-19	2663.002	73075.18	107.654	1.80395	0.10395	1.100924	1.289224	4393.862	1.411201	1.05988	0.020998	0.206376								
H46-20	2577.108	70550.87	126.5308	0.23278	0.944564	1.473398	4.445564	4444.564	1.72	0.944591	0.04831	0.420476								
H46-21	2607.315	71620.84	54.3263	3.85463	0.02031	0.85463	4.255106	4255.016	1.035051	0.944392	0.035204	0.02233								
H46-22	2600.128	72279	55.7802	1.820803	0.28599	1.116932	2.252152	4528.004	1.146514	0.962661	0.06817	0.626588								
H46-23	2719.016	84305.92	52.2066	4633081	0.19965	1.232325	7.264751	4286.273	1.215888	2.435976	2.187575	0.809295								
H46-24	2719.436	82386.44	53.88665	4.177952	0.324045	1.026908	7.344703	4361.902	1.206476	1.306126	0.005	0.064916								
H46-25	3042.666	71481.34	54.14845	3.333147	0.287943	0.977459	4.5441	4378.816	1.233678	1.491741	0.005	0.005676								
H46-26	2971.164	74082.11	53.0702	4.049274	0.174021	0.923822	8.439704	4516.887	1.188275	0.892012	0.006282	0.371228								
H46-27	2894.898	77610.02	54.82558	4.532343	0.144235	0.765293	3.53878	4508.522	1.097395	0.575601	0.048087	0.294567								
H46-28	2234.597	102679	226.2802	25.3516	0.203877	1.198139	2.161525	4766.039	70.61396	2.64816	0.070309	1.845913								
H46-29	2337.108	68899	287.6701	20.39346	0.513577	1.477682	1.753239	5770.699	90.03003	0.343003	0.017612	0.366638								
H46-30	2223.209	69169.75	300.8434	21.29761	0.101861	1.143993	1.56612	5696.096	97.19534	0.410924	0.041624	0.60152								
H46-31	2231.669	75005.83	288.9598	20.57099	0.460358	1.159653	1.82419	5366.627	96.12533	0.460609	0.027371	0.783979								
H46-32	2306.476	71926.31	285.5743	21.02844	0.21716	1.532416	1.806422	5590.626	85.13361	0.400405	0.020998	0.528442								
H46-33	2392.427	70754.42	53.01964	18.62728	0.0728	1.145139	6.355092	4482.302	1.543903	0.964472	0.005	0.005								
H46-34	2663.002	73075.67	107.5577	1.80395	0.087865	0.947098	1.289224	4393.862	1.411201	1.05988	0.056789	0.183471								
H46-35	2663.002	73075.67	53.131301	1.80395	0.087865	0.947098	1.289224	4393.862	1.411201	1.05988	0.056789	0.183471								
H46-36	2207.315	72279	55.7802	1.820803	0.16899	1.116933	2.252152	4286.273	1.215888	2.435976	2.187575	0.809295								
H46-37	2600.128	72279	55.7802	1.820803	0.16899	1.116933	2.252152	4286.273	1.215888	2.435976	2.187575	0.809295								
H46-38	2719.016	84305.92	52.2066	4633081	0.19965	1.232325	7.264751	4286.273	1.215888	2.435976	2.187575	0.809295								
H46-39	2718.436	82386.44	53.88665	4.177952	0.324045	1.026908	7.344703	4361.902	1.206476	1.306126	0.005	0.051915								
H46-40	2668.102	82386.44	53.88665	4.177952	0.324045	1.026908	7.344703	4361.902	1.206476	1.306126	0.005	0.051915								
H46-41	3046.271	122511.4	248.447	25.85917	0.347832	1.325515	3.786717	4572.232	92.21844	0.703093	0.026726	3.149485								

Select Data

please select your data

\$B\$7:\$M\$27

ok cancel

Start

(4) Finally, this program will automatically generate the genetic types of Zn-Pb deposits for the selected data, as well as the probability of belonging to each type of the deposits or some other detailed information.

The probability of belonging to each type of the deposits

The final discrimination type

The results

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Haibugao																				
H46-1	4711.864	108374.1	112.6546	9615.052	0.267641	1.340979	100.3526	5106.580	30.02669	39.32845	0.036483	1.238016								
H46-2	6150.829	118068.9	142.7897	24.58237	0.005	1.862444	35.7318	5063.226	28.67403	4.209614	0.123294	10.99479								
H46-3	5111.879	107387	116.2506	2398.860	0.16567	0.234515	28.39021	4992	27.96232	5.095984	0.005	0.110833								
H46-4	4763.38	112621.6	0.102695	7668.539	0.187827	1.863474	82.37607	4891.16	26.0794	9.043279	0.042329	5.467648								
H46-5	5666.265	114218.1	133.7943	231.0966	0.526063	0.960197	7.213031	4918.953	27.9094	7.687126	0.027003	1.02501								
H46-6	6072.465	122256.6	107.6828	17.86786	0.072102	1.694678	4.765586	4842.811	26.51851	3.95371	0.005	0.344432								
H46-7	6032.3	117127.3	112.3911	12.8118	0.101349	1.204942	2.962267	4946.762	28.2416	4.561229	0.024447	0.209343								
H46-8	5860.182	117676.7	113.9295	11.53639	0.12158	1.289101	2.468859	5019.118	27.80587	5.82483	0.005	0.136121								
H46-9	5942.98	125597.6	122.0724	56.76912	0.180071	1.707167	10.38179	4												

Note: Only the random forest model and XGBoost model have the probability of belonging to each type of the deposits, while the decision tree model does not. The SVM model uses the 'one vs one' decision function, which combines 5 different types pairwise to obtain 10 different types of combinations. The function value is proportional to the distance from sample X to the separation hyperplane. Positive value indicate that the sample belongs to the deposit type before "vs", while negative value indicate that the sample belongs to the deposit type after "vs". Based on the comprehensive statistics of the 10 combinations of Zn-Pb deposit types, the type with the highest number of votes is determined as the genetic type to which the sample belongs. For details, please refer to <https://scikit-learn.org/stable/modules/generated/sklearn.svm.SVC.html#svc>.