Anderson Materials Evaluation, Inc.

Materials Characterization & Failure Analysis

Laboratory Applied Materials Problem Solutions by

Ph.D. Scientists

XPS Surface Analysis, WD-XRF, SEM/EDX, FTIR-ATR, Thermal Analysis (TGA, DSC, TMA), XRD, LIBS, 3D Optical Microscopy, Cross Section Analysis, Corrosion Analysis, RGA MS GC-MS, Adhesive Bonding Failure Analysis, Mechanical Testing, Metallography, Fractography, Contact Angle Measurement, Surface Profilometry, UV-Vis, Reflectivity, Color, Density/Porosity

9051 Red Branch Road, Suite C
Columbia, MD 21045-2103
410-740-8562
Fax 410-740-8201
www.andersonmaterials.com

Email: CAnderson@AndersonMaterials.com

DATE 6 January 2026

TO Client Name Withheld

FROM Griffin Spence, Ph.D., Shreyasi Sengupta, Ph.D., and Charles R. Anderson, Ph.D.

SUBJ Analysis of Jewelry from China Sold as Lab-Certified Grade A Jadeite

Summary

Two containers, each containing jewelry from China sold as lab-certified Grade A jadeite, were sent to Anderson Materials Evaluation, Inc. to determine the real composition of the materials. One piece was shaped as a Buddha and the other was a slab pendant, which are identified in this report as the Buddha and Slab samples. The two materials were analyzed using FTIR, XRF, and XRD, and the following conclusions were drawn:

- The FTIR spectra of the Buddha and Slab Pendant pieces in both transmission and absorbance modes are not matches to jade, proving that jade is either not present or not the primary compound. Small peaks from ~2800 – 3000 cm^{-1} suggest the presence of a minor concentration of organic or organometallic compounds.

- The XRF analysis of the Buddha sample shows that, of the detectable elements, SiO_2 (55.64 wt.%) is the predominant oxide in the sample, followed by CaO (12.20 wt.%), Al_2O_3 (11.96 wt.%), Na_2O (8.61 wt.%), MgO (8.57 wt.%), and Fe_2O_3 (2.27 wt.%), with each of the other oxides being less than 1 wt.%. Assuming that the material is pure jadeite, it would be expected to have an atomic ratio of Na:Al:Si to 1:1:2 and there would not be high concentrations of CaO, MgO, and Fe_2O_3, as is the case with this material. The measured Na:Al:Si ratio is 1.000:0.844:3.332, so there is much too much silicon in this material. Chromium oxide is present, which is used to enhance the green coloration. The XRF analysis implies that the material is not jadeite or jadeite is mixed with something else.

- The XRF analysis of the Slab sample shows that, of the detectable elements, SiO_2 (63.15 wt.%) is the predominant oxide in the sample, followed by Al_2O_3 (14.01 wt.%), Na_2O (7.79 wt.%), CaO (7.33 wt.%), MgO (5.72 wt.%), and Fe_2O_3 (1.34 wt.%), with each of the other oxides being less than 1 wt.%. the elemental composition ratio of Na:Al:Si of the Slab sample does not line up with what is expected, 1.000:1.094:4.181. In addition, there are high concentrations of calcium, magnesium, and iron. Chromium oxide is present, which is used to enhance the green coloration. The XRF analysis proves that the material is not jadeite or jadeite is mixed with something else.

- The XRD analysis of the Buddha sample shows that the main crystalline material by weight is determined to be diopside (93.1 wt.%), with clinoferrosilite (6.9 wt.%) as a minor contributor. No jadeite was found in this material.

- The XRD analysis of the Slab sample shows that the main crystalline material by weight is determined to be omphacite (72.8 wt.%), with jadeite (27.2 wt.%) as a minor contributor.

In conclusion, neither the Buddha nor the Slab sample is jadeite Grade A. The Slab sample had a minority content of jadeite in the form of small particles, while the Buddha sample had no jadeite at all. Both the Buddha and Slab samples were claimed to be jadeite Grade A by two laboratories in China according to certification documents provided with the sale. This was clearly a case of fraud, which is not unusual for products sold by companies based in China.

Sample Background

Two containers, each containing jewelry from China sold as Grade A jadeite, were sent to Anderson Materials Evaluation, Inc. to determine the real composition of the materials. One piece was shaped as a Buddha and the other was a slab pendant (see Figure 1). For conciseness in this report, the material on the left in Figure 1 will be called "Buddha" and the one on right will be called "Slab".



Figure 1. Image of the as-received presumably fake jade samples.

Jade is either nephrite or jadeite. Nephrite is an amphibole mineral, composed of either tremolite or actinolite. Tremolite has the composition $Ca_2Mg_5Si_8O_{22}(OH)_2$, while actinolite is $Ca_2(Mg, Fe)_5Si_8O_{22}(OH)_2$. The hardness of nephrite is 5 – 6.5 Mohs. Jadeite is a pyroxene mineral with the composition $NaAlSi_2O_6$ and a greater hardness of 6.5 – 7.0 Mohs. Jadeite is rarer than nephrite and more valuable. Grade A jade gemstone is natural, untreated jadeite. Grade B jade is jadeite enhanced with resin. Grade C jade is jadeite enhanced with colorant.

The Buddha sample was certified to be Type A jade and came with the certificates in Figures 2 and 3:



CMA 212521340001 资质认定实验室

ilac-MRA 国际互认实验室

CNAS 中国认可 国际互认 检测 TESTING CNAS L19798 国家认可实验室

华首 国检 HSNGTC®

国家认证实验室　国家级珠宝检测中心

Certificate official website:	www.hsngtc.com
Query code:	4028
Testing agency:	**Group headquarters: Beijing Huashou National Inspection Jewelry Testing Group Co., Ltd.** **Holding subsidiary: Huashou Jewelry Quality Inspection (Ruili City) Co., Ltd.**

Certificate verification results

picture:

Test Results	Jadeite (Grade A)

Figure 2a. The Beijing Huashou National Inspection Jewelry Testing Group Co. Ltd. Certified the Buddha sample material to be Grade A Jadeite. This is page 1.



Test Results	Jadeite (Grade A)
Total Mass	17.02g (total weight)
Color: **Color**	See the real thing
Infrared Spectrum	Jadeite characteristic spectrum
Precious Metal Detection:	---
Remarks	---
Identifier: **Tester**	Zhang Kaidie
Reviewer: **Supervisor**	Wang Qian

华玉珠宝首饰质量检测（瑞丽市）有限公司 检验检测专用章

本证书结果仅对照片所示样品负责，仅代表当时科技水平,不作为贸易的质量评价及担保，如对证书有疑问或异议，请于证书签发之日起十五日内向我单位提出，否则视为无异议。

如果您在查询过程中发现有任何疑问或者建议，请您及时与本单位联系，谨防假冒本单位证书或签证。

Figure 2b. The Beijing Huashou National Inspection Jewelry Testing Group Co. Ltd. Certified the Buddha sample material to be Grade A Jadeite. This is page 2.



Figure 3. HSNGTC is a laboratory in China that appears to use FTIR and microscopy to authenticate jewelry materials. Its website is entirely in Chinese, https://www.hsngtc.cn/ HSNGTC also claims that the Buddha sample is Grade A jadeite (Translation of Test Results line), based on a jade characteristic infrared spectrum.



国家认证实验室　国家级珠宝检测中心

证书官网：	www.hsngtc.com
查询码：	1031
检测机构：	集团总部：北京华首国检珠宝检测集团有限公司 控股子公司：华首珠宝首饰质量检测（瑞丽市）有限公司

证书验证结果

图片：

Figure 4a. HSNGTC also certified the Slab sample to be Jadeite Grade A. This is page 1.



检测结论: Test Results	翡翠（A货）
总质量: Total Mass	7.43g（总重）
颜色: Color	见实物
红外光谱: Infrared Spectrum	翡翠特征光谱图
贵金属检测: Precious Metal	---
备注: Remarks	---
鉴定者: Tester	张凯蝶
审核者: Supervisor	王乾

本证书结果仅对照片所示样品负责，仅代表当时科技水平,不作为贸易的质量评价及担保，如对证书有疑问或异议，请于证书签发之日起十五日内向我单位提出，否则视为无异议。

如果您在查询过程中发现有任何疑问或者建议，请您及时与本单位联系，谨防假冒本单位证书或签证。

Figure 4b. HSNGTC also certified the Slab sample to be Jadeite Grade A (see the Test Result line) based on the jade characteristic infrared spectrum. This is the continuation of the page in Figure 4a.

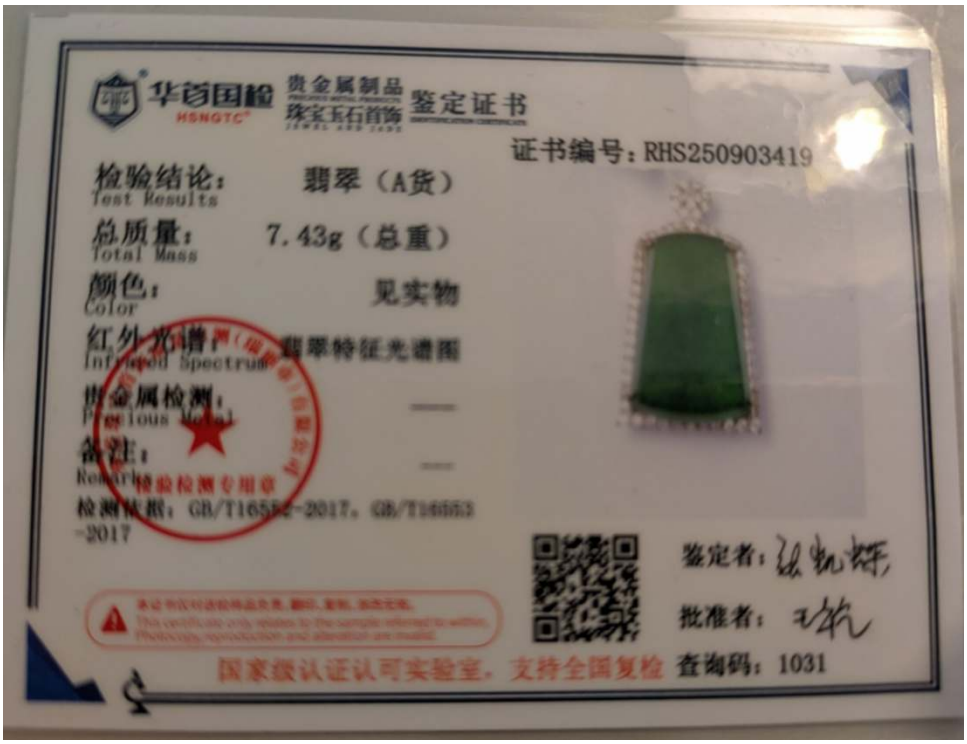




Figure 5. The Jadeite Grade A certification of the Slab sample issued by HuaShou National Lab is shown above. See the Test Results line in the upper image. Each of the claims on this material were claimed to be based on Jade characteristic infrared spectrum.

FTIR Analysis

FTIR data were collected using a JASCO 6100 infrared spectrometer equipped with a mid-infrared ceramic source, a DLaTGS detector, and a Golden Gate Attenuated Total Reflectance (ATR) KRS-5-Cell. The spectrum was analyzed using BioRad's KnowItAll informatics system, JASCO IR edition, The spectra were matched using the libraries contained in Fiveash Data Management's ATR databases.

FTIR spectra of Buddha and Slab are shown in Figures 6 and 7. Both the transmission (Figure 4) and absorbance (Figure 5) are compared to jadeite. Neither sample has spectra showing a close match to the spectra of jadeite. Jadeite is either not present or not the primary compound. The small peaks from ~2800 – 3000 cm^{-1} in the two samples are due to the presence of minor concentrations of organic or organometallic compounds.

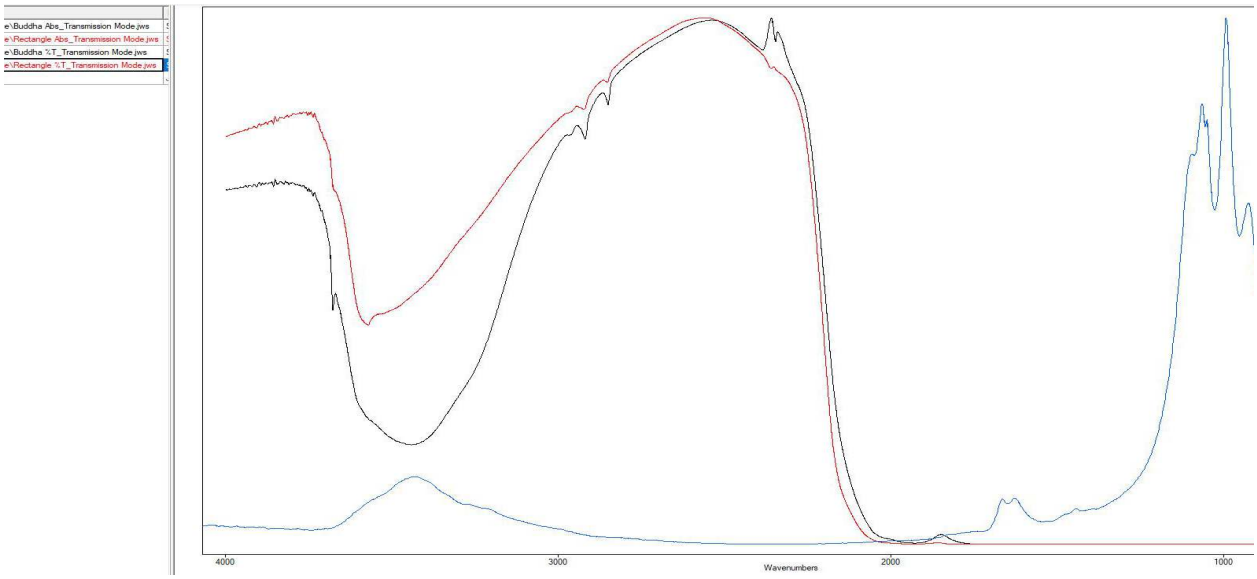


Figure 6. Transmission FTIR spectra of Buddha (black) and Slab (red) overlayed on the known spectrum for jadeite (blue). In transmission, neither sample allows significant transmission for wavenumbers below 2000 cm^{-1}.

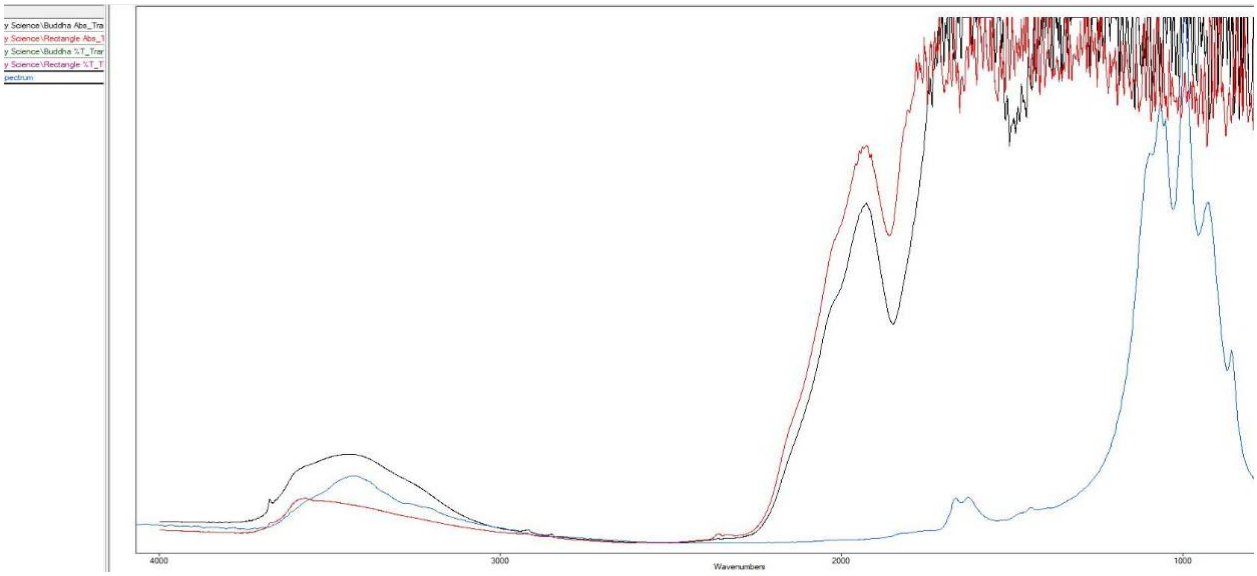


Figure 7. Absorbance FTIR spectra of Buddha (black) and Slab (red) overlayed on the known spectrum for jade (blue). The absorbance spectra were converted from the transmission spectra in Figure 2.

XRF Spectrometry Analysis

Our wavelength dispersive XRF spectrometer can quantitatively measure the elemental concentrations for all elements from fluorine through uranium. When the material has a low density, as in polymers, we can also analyze carbon and nitrogen using an additional crystal. The depth of analysis depends upon the characteristic x-ray energy emitted from the detected element and the density of the material. This depth can vary from a micrometer to a millimeter. XRF analysis has very low detection limits for the elements. Wavelength-dispersive XRF systems have greater elemental sensitivity and higher energy resolution compared to less expensive energy-dispersive XRF spectrometers, allowing detection of all but the lightest elements at concentrations as low as 10 ppm. Solid samples, powders, and liquids can be analyzed with XRF analysis. Our spectrometer also has an unusual small spot capability to measure spots of 0.5 or 1.5-mm diameter, as well as the capability to measure areas of 10 mm and 29 mm diameter. Of course, large area measurements offer lower detection limits and greater accuracy of measurement. For this work, the 29 mm aperture was used, and the samples were analyzed in vacuum. Carbon was not quantified as precise quantification of carbon is not possible due to its low energy fluorescent X-rays.

The oxide composition of Buddha sample is presented in Figure 8. Before normalization, the total weight percent detected assuming the detected elements were in their common oxide form was estimated to be approximately 93.5%. XRF wt.% normalization adjusts the measured element percentages, so they add up to 100%. Light elements such as lithium, beryllium, boron, and oxygen are not detected in the XRF analysis. The results indicate that, of the detectable elements, SiO_2 (55.64 wt.%) is the predominant oxide in the sample, followed by CaO (12.20 wt.%), Al_2O_3 (11.96 wt.%), Na_2O (8.61 wt.%), MgO (8.57 wt.%), and Fe_2O_3 (2.27 wt.%), with each of the other oxides being less than 1 wt.%. Assuming that the material is pure jadeite, it would be expected to have an atomic ratio of Na:Al:Si to 1:1:2 and there would not be high concentrations of CaO and Fe_2O_3, as is the case with this material. The actual measured elemental percentages are given in the right column of Figure 8. Converting the elemental weight percentages into atomic percentages gives a Na:Al:Si ratio of 1.000:0.844:3.332. There is far too much Si in this material to be a good match to jadeite, so the material is not jadeite or jadeite is mixed with something else richer in silicon. In addition, there are high concentrations of calcium, magnesium, and iron. Note also that chromium oxide is present, which is used to enhance the green coloration. The material is not jadeite or jadeite is mixed with something else.

The oxide composition of the Slab sample is presented in Figure 9. Before normalization, the total weight percent detected assuming the detected elements were in their common oxide form was approximately 90.6 wt.%. The results indicate that, of the detectable elements, SiO_2 (63.15 wt.%) is the predominant oxide in the sample, followed by Al_2O_3 (14.01 wt.%), Na_2O (7.79 wt.%), CaO (7.33 wt.%), MgO (5.72 wt.%), and Fe_2O_3 (1.34 wt.%), with each of the other oxides being less than 1 wt.%. Similar to the Buddha sample, the elemental composition ratio of Na:Al:Si of the Slab sample (calculated from the right column of Figure 9) does not line up with what is expected, 1.000:1.094:4.181. In addition, there are high concentrations of calcium, magnesium, and iron. Note also that chromium oxide is present, which is used to enhance the green coloration. The material is not jadeite or jadeite is mixed with something else.

Anderson Materials Eva. - US

12/18/2025 5:40:57PM
Calculated by UniQuant
Thermo Fisher Scientific

Buddha - Tribology Science

PFX-099 Rh 60kV LiF200 LiF220 Ge111 AX03
Method : X_UQi with CN
Kappa List : AnySample
Shapes & ImpFc : Teflon
Calculated as : Oxides
Case Number : 0 = All known

Measure time : 12/16/2025 12:37:27AM
X-ray Path: : Vacuum
Film Type : None
Collimator Mask : 29 mm
Viewed Diameter = 29.00 mm
Viewed Area = 660.52 mm2
Viewed Mass = 1808.78 mg
Sample Height = 0.63 mm

Reporting Level > 10 ppm and wt% > 3 Est.Err.

Compound	Wt%	Est.Error	Element	Wt%	Est.Error
SiO2	55.64	0.25	Si	26.01	0.12
CaO	12.20	0.29	Ca	8.72	0.21
Al2O3	11.96	0.16	Al	6.33	0.09
Na2O	8.61	0.31	Na	6.39	0.23
MgO	8.57	0.14	Mg	5.17	0.08
Fe2O3	2.27	0.07	Fe	1.59	0.05
Cr2O3	0.247	0.012	Cr	0.169	0.0084
S	0.168	0.0084	S	0.168	0.0084
TiO2	0.111	0.0056	Ti	0.0667	0.0033
NiO	0.0603	0.0030	Ni	0.0474	0.0024
MnO	0.0521	0.0026	Mn	0.0403	0.0020
Cl	0.0490	0.0025	Cl	0.0490	0.0025
P2O5	0.0244	0.0013	Px	0.0106	0.0006
K2O	0.0193	0.0010	K	0.0160	0.0008
ZnO	0.0120	0.0006	Zn	0.0096	0.0005
SrO	0.0041	0.0003	Sr	0.0035	0.0003
MoO3	0.0034	0.0008	Mo	0.0023	0.0006
Co3O4	0.0025	0.0005	Co	0.0018	0.0003
V2O5	0.0023	0.0007	V	0.0013	0.0004
ZrO2	0.0014	0.0005	Zr	0.0011	0.0003
Ga2O3	0.0013	0.0003	Ga	0.00094	0.0002

Sum Weight% before normalization to 100% = 93.5 %
Total Weight% Oxygen = 45.21

Figure 8. XRF oxide analysis of the Buddha.

Anderson Materials Eva. - US

12/18/2025 5:43:03PM
Calculated by UniQuant
Thermo Fisher Scientific

Rectangle - Tribology Science

PFX-099 Rh 60kV LiF200 LiF220 Ge111 AX03

Method	: UQ_10mm		Measure time	: 12/17/2025	3:51:59PM
Kappa List	: AnySample		X-ray Path:	: Vacuum	
Shapes & ImpFc	: Teflon		Film Type	: None	
Calculated as	: Oxides		Collimator Mask	: 29 mm	
Case Number	: 0 = All known		Viewed Diameter	= 10.00	mm
			Viewed Area	= 78.54	mm2
			Viewed Mass	= 115.64	mg
Reporting Level	> 10 ppm and wt% > 3 Est.Err.		Sample Height	= 0.34	mm

Compound	Wt%	Est.Error	Element	Wt%	Est.Error
SiO2	63.15	0.24	Si	29.52	0.11
Al2O3	14.01	0.17	Al	7.42	0.09
Na2O	7.79	0.30	Na	5.78	0.22
CaO	7.33	0.23	Ca	5.24	0.17
MgO	5.72	0.12	Mg	3.45	0.07
Fe2O3	1.34	0.06	Fe	0.939	0.04
Cr2O3	0.242	0.012	Cr	0.166	0.0083
TiO2	0.153	0.0076	Ti	0.0917	0.0046
NiO	0.0575	0.0029	Ni	0.0452	0.0023
BaO	0.0515	0.014	Ba	0.0462	0.013
MnO	0.0408	0.0020	Mn	0.0316	0.0016
Cl	0.0296	0.0020	Cl	0.0296	0.0020
ZrO2	0.0251	0.0013	Zr	0.0186	0.0009
S	0.0151	0.0016	S	0.0151	0.0016
K2O	0.0132	0.0010	K	0.0110	0.0008
P	0.0053	0.0010	P	0.0053	0.0010
Au	0.0036	0.0007	Au	0.0036	0.0007
ZnO	0.0034	0.0005	Zn	0.0027	0.0004
SrO	0.0032	0.0003	Sr	0.0027	0.0003
V2O5	0.0031	0.0010	V	0.0017	0.0005
Ga2O3	0.0014	0.0004	Ga	0.0011	0.0003

Sum Weight% before normalization to 100% = 90.6 %
Total Weight% Oxygen = 47.18

Figure 9. XRF oxide analysis of Slab sample.

XRD Analysis

XRD analysis was performed using a Rigaku Miniflex 600 benchtop XRD. Data acquisition and analysis were performed using smart lab studio II software. The samples were analyzed in the 2θ range from 3˚ to 90˚, with step size of 0.01˚ at a rate of 5˚/min. The ICDD PDF 4 Axiom package was used for phase identification and Whole Powder Pattern Fitting (WPPF) analysis was performed to quantify the identified phases.

Figure 10 shows the XRD report of the Buddha sample. The main crystalline material by weight is determined to be diopside (93.1 wt.%), with clinoferrosilite (6.9 wt.%) as a minor contributor. The smaller the value of Rwp (%), or closer the S value to 1, indicates the measured data and calculated data match well. The Rwp is 13.76% and S is 6.85, indicating a moderately good fit of calculated and experimental data. While these values are relatively high, it is likely because of the curved surface of the sample. The XRD peak position typically increases in accuracy with flatness of the sample. In Figure 11, a known jadeite diffraction pattern is shown as a reference to what would be expected if the sample was actually jadeite. However, in this case, the diffraction pattern of Buddha clearly does not match with jadeite and no significant concentration of jadeite is in the material.

Figure 12 shows the XRD report for the Slab sample. The main crystalline material by weight is determined to be omphacite (72.8 wt.%), with jadeite (27.2 wt.%) as a minor contributor. The smaller the value of Rwp (%), or closer the S value to 1, indicates the measured data and calculated data match well. The Rwp is 5.76% and S is 2.94, indicating an excellent fit of calculated and experimental data. Since this sample is much flatter than Buddha, the Rwp and S are considerably lower.

While all minerals detected in both samples belong to the pyroxene group, it is clear that neither sample qualifies principally jadeite, let alone as Type A jadeite. The Buddha sample has no jadeite and the Slab sample has a minority concentration of jadeite. The fact that most of the identified minerals are naturally green explains the visual resemblance to jade, as does the chromium found in each sample.

Rwp (%)		13.76
S		6.85
Phases		Weight %
Diopside	$MgCaSi_2O_6$	93.1
Clinoferrosilite	$FeSiO_3$	6.9

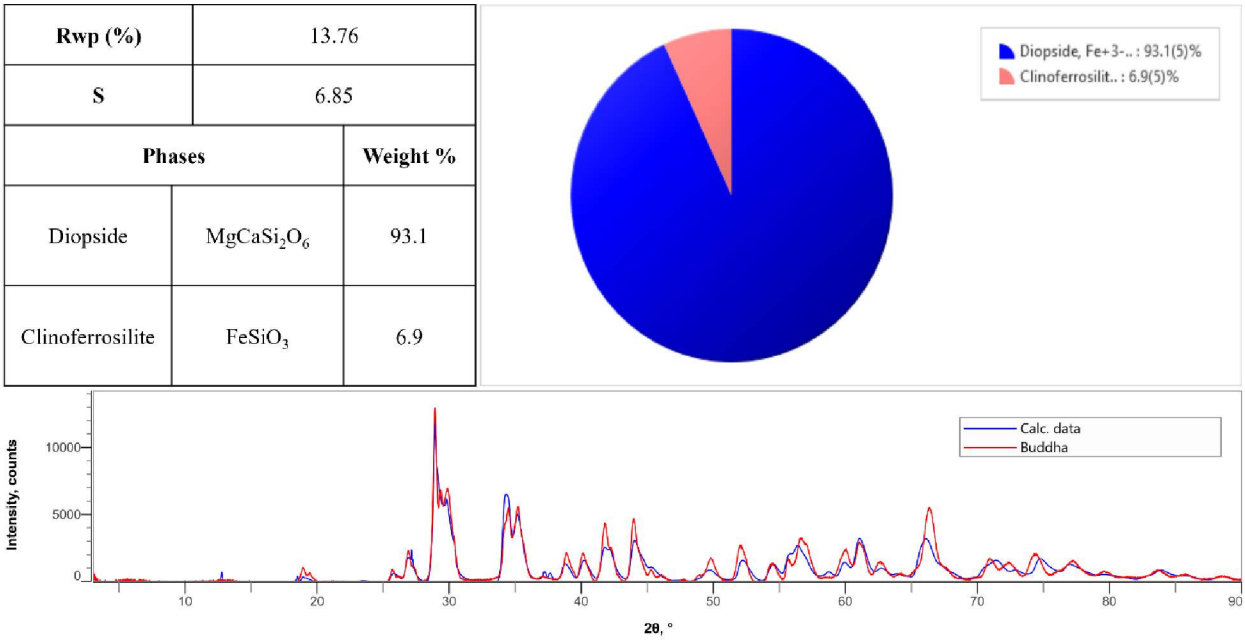


Figure 10. XRD report on the Buddha sample. In the bottom plot, raw (red line) and calculated (blue line) data are overlayed.

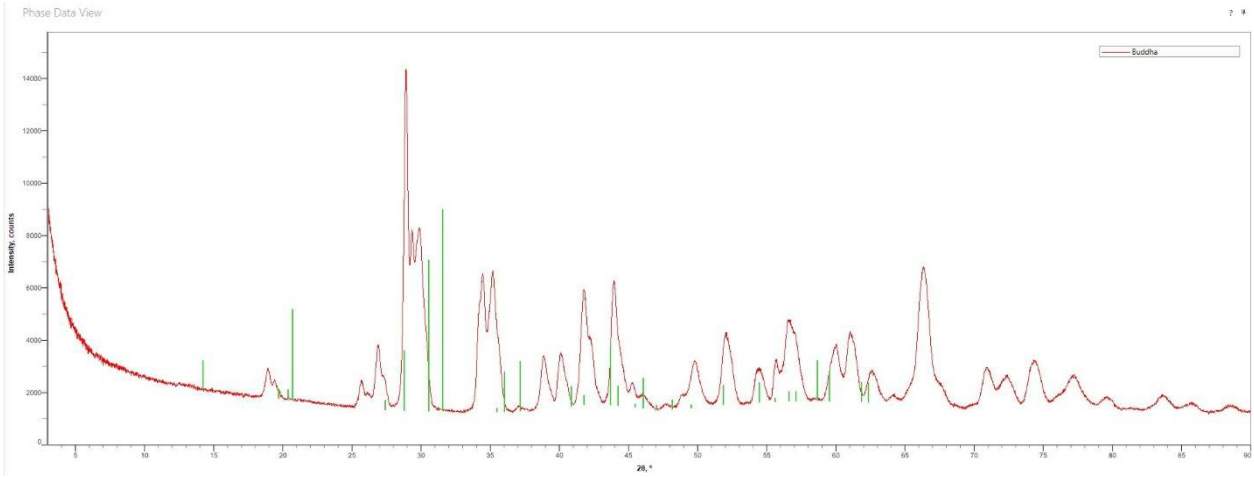
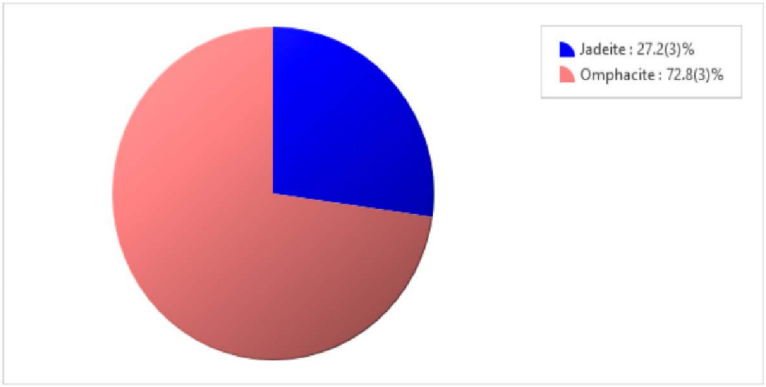


Figure 11. Diffraction pattern of Buddha (red line) overlayed on the known pattern for jadeite (green lines) to serve as a reference. There is clearly no significant concentration of jadeite in this sample.

Rwp (%)	5.76	
S	2.94	
Phases		Weight %
Omphacite	(Ca,Na)(Mg, Fe^{2+},Al)Si_2O_6	72.8
Jadeite	Na(Al,Fe^{3+}) Si_2O_6	27.2



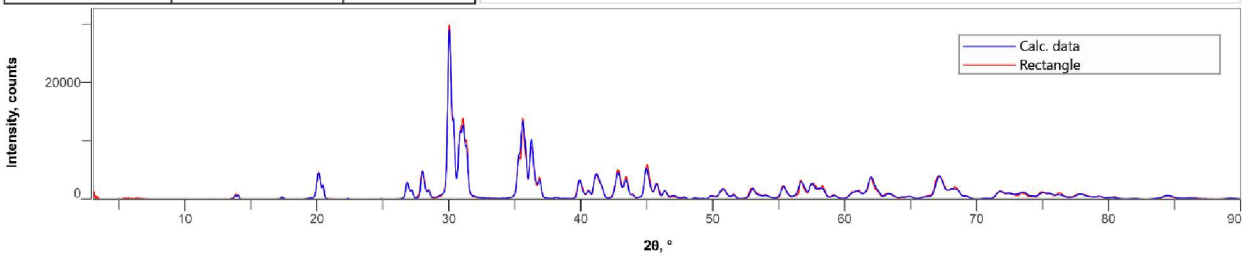


Figure 12. XRD report on the Slab sample. In the bottom plot, the raw (red line) and calculated (blue line) data are overlayed.