Characterization of color and composition in chert for grouping and comparison

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ABSTRACT

Color is one of the most commonly used characteristics in archaeological studies to differentiate and describe chert. In this study we have quantified color parameters and analyzed their correlation with chemical composition in a collection of chert from different outcrops.

Key Words: Chert, Color, Reflectances, CIELab, SPSS.

INTRODUCTION

Chert is one of the most important materials used as a resource by Stone Age humans, and color is one of the most used characteristics in archaeological studies to differentiate and describe chert.

This property is difficult to determine, as it depends on many factors: the perception of the person observing it, the external light source providing the illumination, the composition, structure and texture of the chert.

OBJECTIVES

1. To quantify color parameters.
2. To analyze the correlation of color with chemical composition.
3. To have color references of chert from different geographic and geological origins for use in archaeological tool characterization studies.

GEOGRAPHIC LOCALIZATION

The analyzed cherts belong to outcrops from different geographical locations, mainly European (Spain and France) and American (USA and Venezuela).
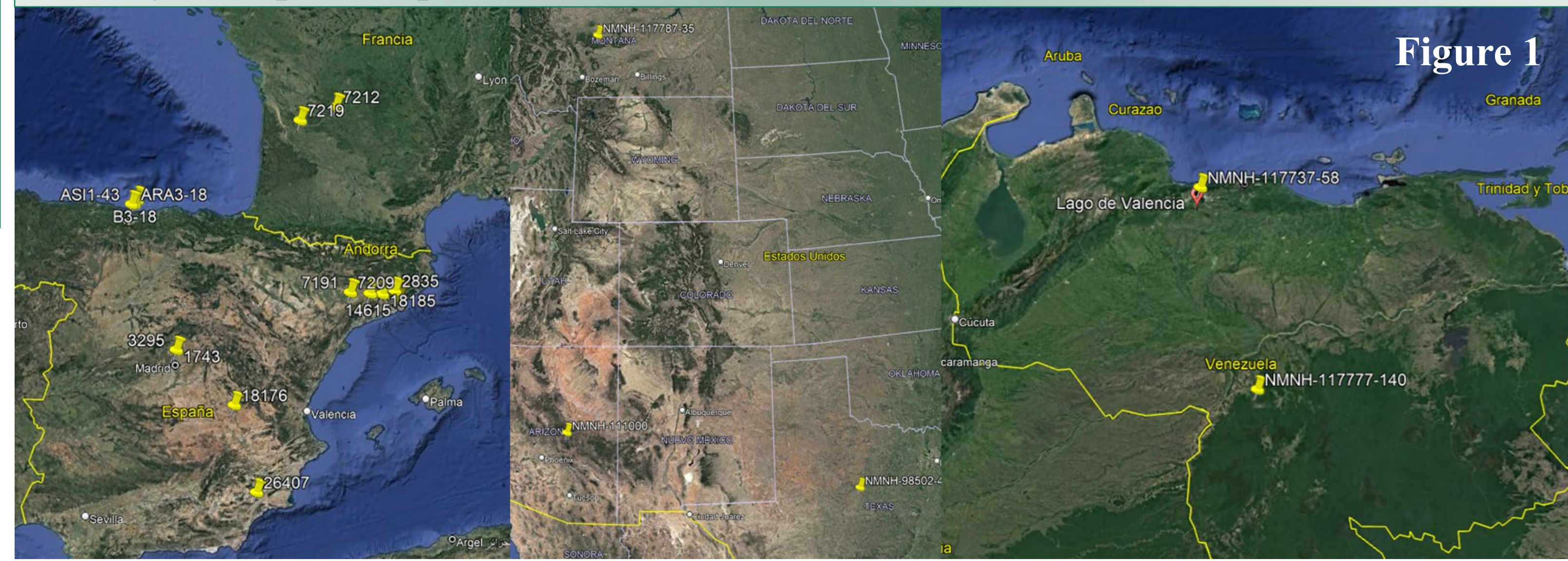

Figure 1

METHODOLOGY

The composition of the elements expressed in oxides (%) has been obtained by X-ray fluorescence with a Shimadzu EDX-720 equipment. The chromatic coordinates were obtained from the flint reflectances measured with an Edinburgh Instrument FS5 spectrophotometer in the range of 300-800 nm, at 5 nm intervals. The CIE 1931 diagram (*http://sciapps.sci-sim.com/CIE1931.html*) was used to represent the chromatic coordinates. RGB coding and CCT (K) color temperature were obtained using the NIX converter (*www.nixsensor.com/free-color-converter/*). The color cluster analysis and the correlation between color and composition were calculated with the SPSS statistical program (IBM SPSS Version 24).

RESULTS

Table 1

Composition (% in oxides) and chromatic coordinates

Muestras	Localización	SiO2	CaO	Al2O3	K2O	Fe2O3	TiO2	SO3	SrO	ZrO2	RGB	CCT(K)
10067	Sants-Montjuïc, Barcelona	93.27	0.06	5.79	0.81	0.00	0.05	0.02	0.00	0.00		5001.9
14615	Pontils, Tarragona	74.81	1.44	13.02	8.08	2.04	0.24	0.37	0.00	0.00		5119.6
1743	Área Metropolitana y Corredor de Henares, Madrid	96.00	1.91	0.00	0.31	1.32	0.00	0.22	0.00	0.00		4990.9
18176	Sisante, Cuenca	94.61	0.00	5.28	0.00	0.06	0.00	0.03	0.00	0.00		4887
18185	Sant Pere de Riudebitlles, Barcelona	88.74	0.52	7.21	2.91	0.33	0.12	0.15	0.01	0.00		4832.1
26360	Área Metropolitana y Corredor de Henares, Madrid	95.12	0.12	4.44	0.11	0.22	0.00	0.00	0.00	0.00		4704.2
26407	Lorca, Murcia	95.03	1.44	0.00	1.66	1.32	0.00	0.11	0.00	0.00		4239.4
2835	Rubí, Barcelona	97.62	0.00	2.32	0.00	0.06	0.00	0.00	0.00	0.00		5016.7
3295	Área Metropolitana y Corredor de Henares, Madrid	91.58	0.32	7.22	0.60	0.19	0.00	0.05	0.00	0.00		4832.8
6343	L'Hospitalet de Llobregat, Barcelona	95.13	0.00	4.74	0.00	0.05	0.00	0.01	0.00	0.00		5197.6
7182	Gràcia, Barcelona	98.07	1.73	0.00	0.00	0.00	0.00	0.03	0.10	0.00		5253.7
7186	Área Metropolitana y Corredor de Henares, Madrid	95.78	0.00	4.08	0.00	0.00	0.00	0.03	0.00	0.00		4796.6
7191	Les Borges Blanques, Lleida	83.29	0.83	11.43	3.11	1.20	0.00	0.10	0.00	0.00		4921.1
7209	Les Borges Blanques, Lleida	94.00	0.00	5.74	0.00	0.23	0.00	0.02	0.00	0.00		4980.6
7212	Dordogne, Francia	52.02	0.40	44.18	2.15	1.05	0.00	0.03	0.00	0.00		5040.1
7219	Libourne, Francia	99.97	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00		4909.4
7606	Área Metropolitana y Corredor de Henares, Madrid	79.25	10.06	8.50	1.65	0.43	0.00	0.10	0.00	0.00		4811.5
ARA3-18	Arangas, Asturias	96.94	0.87	0.00	1.28	0.47	0.08	0.00	0.01	0.00		4876.6
ASI1-43	Asiego, Asturias	82.29	0.48	10.48	5.32	1.29	0.10	0.02	0.00	0.02		3916.1
B3-18	Ballota, Asturias	72.18	1.51	13.99	9.68	2.20	0.14	0.00	0.00	0.02		4087.9
NMNH 111000	Arizona, EEUU	99.27	0.00	0.00	0.11	0.30	0.00	0.02	0.00	0.00		4153.2
NMNH 117-737-58	Northern Guarico-Lake Valencia Area, Venezuela	67.87	2.32	21.64	4.94	2.90	0.19	0.02	0.04	0.00		5012.7
NMNH 117777-140	Venezuela	42.18	3.04	22.48	6.13	22.46	1.19	0.20	0.02	0.02		5002.6
NMNH 117787-35	Montana, EEUU	92.98	1.28	4.75	0.16	0.81	0.00	0.02	0.00	0.00		4164.2
NMNH-98502-4	Texas, EEUU	92.64	0.56	0.00	2.89	2.24	0.00	0.19	0.01	0.00		4776
S3	Sotres, Asturias	95.05	2.11	2.73	0.00	0.00	0.00	0.02	0.01	0.00		4725.9
V3-15	Vidiago, Asturias	94.29	0.19	5.21	0.20	0.00	0.00	0.02	0.00	0.01		4866.8

Table 2
Pearson correlation % in oxides and CTT

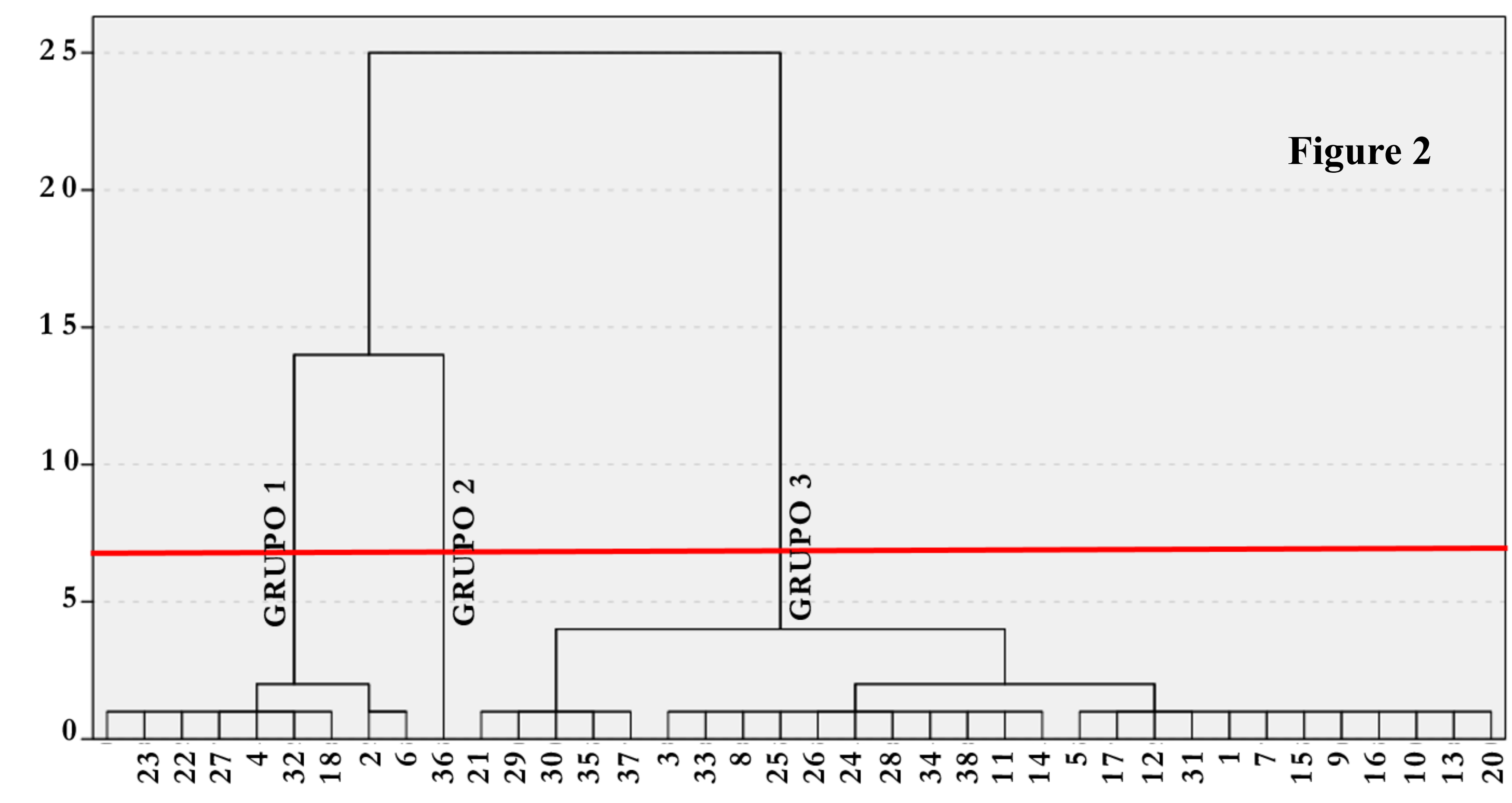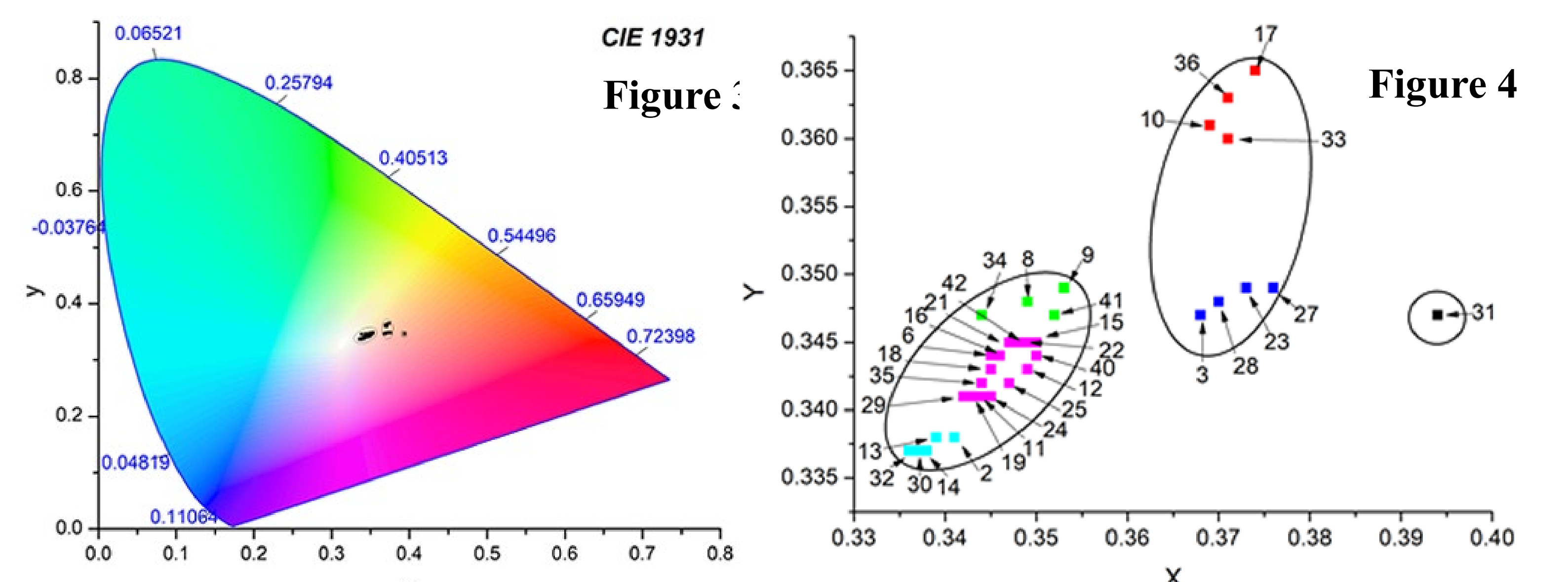| Pearson	SiO2	CaO	Al2O3	K2O	Fe2O3	TiO2	SO3	SrO	ZrO2
CTT	0.7	-0.3	-0.5	-0.6	-0.8	-0.6	-0.1	0.4	-0.3

Figure 2

CIE 1931
Figure 3

Figure 4

DISCUSSION

The Pearson correlation between CCT(K) and the oxide composition of the chert studied (Table 2) is, in general, very low, except for Fe_2O_3 (-0.8), TiO_2 (-0.6) and SiO_2 (0.7).

In the CCT (K) dendrogram (Figure 2) 3 groups have been established, consistent with the groups established in the CIE 1931 chart (Figure 3) and Figure 4. The black chert samples have not been considered because they are not included in the CIE chart.

CONCLUSIONS

The color of the studied chert presents few variations among them since their chromatic coordinates are very close due to the fact that the elemental composition is similar in all of them. This color behavior in the chert studied so far seems to be a trend for others, regardless of their provenance and origin. It is likely that more pronounced differences between the chert can be obtained from reflectances measured in infrared regions, work that is planned to be carried out in the near future.

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