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INITIAL RESEARCH INTO THE CHEMICAL COMPOSITION OF RED INKS IN CHINESE ARTEFACTS

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This brief paper outlines experimental techniques in determining the composition of red ink used in conjunction with stamps or 'chops'. The two artefacts were respectively, the temple seal or 'chop' from the Temple of Hou Wang, Atherton and an ink pad from the Lit Sung Goong, Cairns. It is generally accepted inks of this type are derived from cinnabar (HgS). Tests were proposed to test this hypothesis. To do so we used x-ray diffraction equipment in the Geology Department, James Cook University of North Queensland, Townsville.

X-ray diffractometer techniques examine the internal atomic crystalline structural arrangements of individual atoms. The spacing between the atomic lattices (d values) provide a unique 'fingerprint' of crystal structures enabling scientists to establish chemical formulation of a given substance.

Fine scratchings of red powder were removed from the face of the temple seal to produce sample 1. Sample 2 comprised two resinous aggregates each about the size of a 5 cent piece. These were derived from the relict deposit in the bottom of the ink container.

Portion of Sample 1 was ground with acetone in an agate mortar and pestle and mounted, as a smear, on a glass slide.

The diffractogram defined a single crystalline phase: that of mercury sulphate or cinnabar (HgS).

Sample 2 proved more complex. The ink paste was removed from the substrate using acetone and ground in a mortar and pestle. The ground sample was transferred to a glass slide as a suspension in acetone and the acetone evaporated. Cinnabar (HgS) and at least one other distinct crystalline phase was identified from x-ray diffractogram. The latter phase could not be identified with certainty but is believed to be a stearate salt, probably *mercury stearate.*

(N.B. Sodium stearate is the main component of common soap).

Subtraction of the cinnabar pattern from the diffractogram leaves peaks corresponding to the following *d* relative intensities:

d	I/I	
30.05	100	(002)
19.67	60	(003)
14.49	15	(004)
11.39	5	(005)
8.80	1	
6.97	1	
6.05	0	
4.78	8	
4.15	8	
3.94	10	

Tentative indexing is also given in brackets.

A JDPDS reference pattern for mercury stearate was not available. However the silver stearate pattern (4-0027) was, and when the basal *d* values were converted to take account of the difference in ionic radii between silver (0.89 A) and mercury (1.1 A), the following pattern was obtained:

Silver Stearate (JCPDS, 4-0027)	**Proposed Mercury Stearate (x 1.1/0.89)**	**Sample**
24.0 (002)	29.66	30.05
16.0 (003)	19.78	19.67
12.1 (004)	14.96	14.49
9.67 (005)	11.95	11.39

Such a calculation is reasonable because stearates are layered structures of stearate molecules and metal ions.

Comparisons of this calculated pattern with that obtained from the sample shows good agreement. On this basis the second phase in the sample has been tentatively identified as *mercury stearate* (soap).

Although such a small battery of tests is insufficient to draw any firm conclusions they do suggest first, that x-ray diffractometry is a suitable method by which the chemical composition of artefacts may be analysed. Secondly, there is reason to believe that although cinnabar may have been a commonly used base for red ink it was not an exclusive use.

Clearly it is necessary to conduct further research using additional samples and to subject at least a random selection of those samples to other analytical methods.