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Vinland Map 1999

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ABSTRACT

The Vinland Map has presented scientists with a Turin "Shroud"-like controversy. I published two papers (McCrone 1974, 1976) detailing my microanalytical data proving the Vinland Map (VM) to be a post-1920 production rather than 1440 as proposed by some scholars and book dealers. The map was produced with a yellow ink line to simulate the migration and time-developed (over centuries) yellowing characteristic of all inked documents. The yellow inked lines were then followed by a black ink line skillfully centered down all of the yellow ink lines; an intentionally fraudulent production. The yellow ink consisted of a gelatin base but with two yellow pigments: yellow ochre and a yellow titanium white pigment available only after 1920. There remains no possibility the VM could be authentic.

However, Dr. Thomas Cahill of the University of California (Davis) published a paper (1987) based on the use of PIXE (Proton-Induced X-Ray Emission) that proved to him and to others (especially the Yale University Press) who wished to believe in a pre-Columbus map that the percentage of titanium was too low to produce the VM (specifically 0.0062%). Furthermore Cahill reported that he saw only one ink line, rather than two lines.

I responded (McCrone 1988) by pointing out that the sample size of Cahill's sub-nanogram PIXE samples was 1000 times greater than my yellow ink samples and that all of the titanium was present in the yellow ink lines — as proved by Cahill's own data.

In 1991, I requested permission to revisit the map in Yale's Beinecke Library to remove samples of the yellow ink lines in order to identify the ink medium. These results are reported here in peer-reviewed pages for the first time. The medium is gelatin, a common medieval medium.

INTRODUCTION

The situation with the Vinland Map (VM) is not as bad as for the Turin Shroud but all of the same situation elements are there. The light microscope determined in 1974 the VM to be a forgery. Later, other non-microscopical scientists using inappropriate instrumentation (e.g., PIXE) differed with my forgery conclusion. Since then, the two camps each have their convinced believers. It sounds just like the "Shroud" debacle (McCrone 1999).

A recent letter by Edward Peffer of Cypress, California addressed to the President of Yale University (owners of the VM) contains the following: "Walter C. McCrone states as his factual finding the Turin Shroud is definitely a painting.... While McCrone's theories are no threat to freedom I feel his tendency to limited microscopic scrutiny of evidence taken from the Shroud and his proclamation of those isolated results without peer-review ought to diminish rather than exalt his status as an objective scientist.

"In fact, since McCrone is so self-assured that the Shroud is a 14th Century painting... the question has arisen among Shroud researchers that perhaps McCrone's Work as the microscopist who 'proved' Yale University's 'Vinland Map' is not authentic, ought to be peer-reviewed with use of more powerful and sophisticated equipment available today."

This paper will demonstrate the power of the polarized light microscope (PLM) and the disadvantages of using PIXE for document and map problems. In 1972, Ken Nesheim of Yale's Beinecke Library brought the Vinland Map to McCrone Associates in Chicago for sampling of the ink. During this sampling operation, performed by our ace tiny-particle picker, Anna Teetsov, we found the yellow stain that normally forms very slowly by molecular diffusion of the ink vehicle into the fibers during a few hundred years aging of ink lines could be peeled off with her fine-pointed tungsten needle as a micrometer-thick transparent film. The black lines had been inked very carefully down the middle of all earlier yellow ink lines. This, by itself, proves the Vinland Map is a forgery. The cartographer did the best he could, not having 500+ years before he wished to "discover" the map. His best was excellent. Only in a few places did his hand introduce less than centering of the black ink line down the center of the yellow ink line.

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Careful examination of Anna's samples by PLM showed the transparent yellow ink film to be filled with a variety of fine particles. These were identified principally as submicron titanium white (TiO_2) pigment particles, probably anatase, an off-white yellowish pigment when first produced in 1920. The cartographer evidently chose that pigment because it was slightly yellow and because the tiny particle size would make a good ink. But to be more certain he added a tiny amount of yellow ochre. The latter is an earth pigment and is accompanied inevitably by fine particles of calcite (limestone), and quartz, that we observed, and other lesser quantities of other contaminants that we did not identify specifically.

Later, the electron optics group at McCrone Associates confirmed the TiO_2 to be anatase by selected area electron diffraction (SAED) and the particles thereof, to be indistinguishable by transmission electron microscopy (TEM), from early production samples of anatase TiO_2 pigment particles. They examined and analyzed 35 ink samples Anna had removed. All 29 yellow ink samples were found by TEM and IMA (ion microprobe) to show titanium and in the 21 that were analyzed by PLM the titanium was shown to be in the anatase polymorphic form. X-ray diffraction also found anatase, calcite and quartz in the two yellow films analyzed. Four other yellow ink samples analyzed by TEM/SAED also showed anatase and calcite. Sixteen ink samples were analyzed quantitatively by electron microprobe and showed a range of TiO_2 content from 3-4% to 40-45% with an average of 14-18%. The balance is carbon, calcite, quartz, iron oxide and compounds of sodium, chromium and zinc.

I concluded that the Vinland Map was produced in the early 1920s with a 1920s pigment, anatase TiO_2, in a gelatin vehicle to produce a map done entirely with yellow lines followed by a careful addition of a black iron-gall ink line down the middle of the yellow lines. This proves the intention of producing an old map. The presence of anatase pigment of a type only possible after 1920 confirms its post-1920 origin.

Next, appears Thomas A. Cahill and colleagues at the University of California at Davis. In 1987, they (Cahill et al. 1987) published an article based on a proton milliprobe, PIXE (Proton-Induced X-ray Emission), and concluded: "that titanium and other medium and heavy elements are present in only trace amounts in the inks, with titanium reaching a maximum value of 10 ng/cm^2, or about 0.0062% by weight. In the light of these results the prior interpretation that the Map has been shown to be a 20th Century forgery must be re-evaluated".

Cahill, et al., report finding titanium (PIXE cannot tell whether this is metallic Ti, TiO_2, $TiCl_4$, or ?). They did report finding Ti in the Vinland Map but not in the "associated" documents ("Tartar Relation" and the "Speculum Historiale"). It must be pointed out here that Cahill analyzed Vinland Map samples measuring 1 x 0.5 mm in area and the entire thickness of the parchment (nearly 1 mm thick). My sample was about 1,000 times smaller, being only 1 μm thick. My Ti percentages ranged from about 4 to 40% in the ink line. All of the Ti on the map is present in the yellow ink and not dispersed uniformly throughout Cahill's "mm" sample of ink and parchment. With Cahill's own data (Table 1) essentially all of the titanium is in the yellow ink and 0.0062% times 1,000 (difference in sample size) yields 6.2% Ti, reasonably close to my average of 14-18% TiO_2. That alone shows how Cahill has misinterpreted his own data.

Cahill also analyzed 33 inks by pairing the ink line (A) with adjacent parchment (B). His own data for Ti shown in Table I was all I needed to disprove his final conclusion that the titanium is in the parchment ink lines and not in the parchment. This table shows my percentages are of TiO_2 in the yellow ink itself. Cahill assumes the TiO_2 is in the ink plus parchment, a sample about 1,000 larger than my ink line sample that has all of the TiO_2. It's as simple as that. The TiO_2 is essentially all in the subnanogram yellow ink and not in his submilligram sample of ink plus parchment.

Cahill states that 1/3 of all ink lines showed no titanium whatsoever. What I see in Table 1 is: 24 of 33 show more Ti in the ink lines than in the adjacent parchment. Only 1 (No. 8) is given as definitely less in the ink line and only 8 (10, 11, 14, 22, 24, 29 & 30) could be less but it is just as accurate to say they could be greater. Note: <0.3 includes 0.0. Overall, Table 1 is excellent evidence for Ti in the ink lines and little or no Ti in the adjoining parchment.

Table 1 Ink Parchment Pairs

	A / B		A / B		A / B
1	10.2/<0.3	12	5.6/<0.4	23	1.9/<0.3
2	0.3/<0.3	13	5.6/<0.2	24	0.2/<0.3
3	5.9/2.6	14	0.2/<0.4	25	1.2/<0.3
4	0.7/<0.4	15	3.5/0.4	26	0.4/<0.2
5	3.6/<0.3	16	1.9/<0.4	27	1.1/0.4
6	4.4/<0.3	17	2.1/<0.3	28	2.7/<0.3
7	1.0/<0.5	18	1.9/<0.4	29	<0.3/<0.3
8	0.4/0.5	19	0.5/<0.3	30	0.3/<0.5
9	1.0/<0.3	20	0.9/0.6	31	1.3/<0.3
10	<0.2/<0.2	21	0.8/<0.3	32	<0.2/<0.2
11	<0.2/<0.6	22	0.3/<0.3	33	1.6/<0.3

Averages: A= 1.90, B= < 0.42

Cahill also states that the yellow pigment can't be TiO_2 because TiO_2 is a brilliant white pigment. So it is today, but not in the 1920s before manufacturers were able to remove all of the iron present as impurity from their starting material iron titanate. It was sold for off-white cream-colored house paint in the early 1920s and that is the Vinland Map yellow pigment.

Cahill also disbelieves the two-ink process, one yellow and one black. Instead, he reports a uniform single paint that "separated into the two layers over time"! This is preposterous. Surely such a separation would have to occur before the ink dried yet we see a black ink with no Ti but iron, chromium and sulfur and a yellow ink with Ti but with no iron, chromium and sulfur; miraculous. I find it impossible to imagine a process by which a uniform ink mixture of tiny black, yellow, and colorless (calcite, quartz, etc.) particles could "unmix" to give two discrete layers, one yellow and the other black, all during the minute or two of drying time. One final point on this issue: Most of the black ink has cracked and worn away on the Vinland Map but where it disappeared the original black edges are still apparent and they lie well within the outer yellow ink edges. So separation of the yellow and black inks would also require the anatase and other particles to move away from Cahill's single mixed ink and the iron-gall ink particles to move away from those edges into the black line. I get a headache trying to make that seem possible. Final conclusion: all of the physical evidence supports the two-ink hypothesis and the presence of a post-1920 anatase titanium "white" pigment in the yellow ink lines applied first and therefore underneath the final black ink line of the Vinland Map.

On August 8, 1991, I revisited the Beinecke library to take additional samples of the yellow ink to be able to identify the vehicle in that ink. Several submicrogram samples of yellow ink were removed from the Vinland Map at that time. All were essentially alike, however, one of the largest of these (Figure 1) was carefully examined by polarized light microscopy to show a transparent isotropic film (the ink medium); and, embedded in that film, crystals of calcium carbonate (whiting, limestone), a few potassium feldspar particles, titanium white and a trace of yellow iron earth pigment. That film was then mounted for elemental analysis by scanning electron microscope fitted with an energy-dispersive x-ray analyzer. The elemental analysis (Figure 2) shows: major-calcium (calcite), titanium and sodium; minor-phosphorus, sulfur, and chlorine; and trace-aluminum, potassium and silicon (feldspar minerals). This analysis is very similar to the results obtained 25 years ago. At that time, however, we did not attempt to identify the ink vehicle (medium).

The same film was remounted for FTIR/microscopy in order to identify the ink medium. The results show the medium to be gelatin, an unusual but quite reasonable ink medium (Figure 3). The two spectra (ink and gelatin standard) agree as well as can be expected. The standard curve represents gelatin made from the polypeptides (protein) present in bone. We do not know what the Vinland Map tempera was made from: most likely it is animal skin but chemically similar hooves or horn are also possible. All of these have been used as paint media and all are mixtures of varying percentages of about 20 amino acids. The infrared patterns, therefore, differ only slightly. It is noteworthy that gelatin could be made from parchment. It is, therefore, important to emphasize that yellow ink films did not have any collagen (parchment) fibers in it. Collagen is also easily identified by PLM.

The procedure is to use amido black to prove the sample is proteinaceous by the blue stain then shown. This is followed by testing the fragment with sodium azide (NaN_3) solution. All proteins except collagen, i.e., gelatin, decompose NaN_3 to yield nitrogen bubbles. This non-destructive test was performed on a fragment of the yellow ink film with positive results for gelatin. Nitrogen bubbles did not result because collagen lacks the two sulfur-containing amino acids (cystine and cysteine) that catalyze the decomposition of NaN_3. This test was used to prove the Shroud paint was also gelatin based (McCrone 1990); it is described in "Judgment Day...." (McCrone 1999).

A further proof of this contention is the presence of titanium white pigment particles throughout the yellow ink film. Photomicrographs taken at one micron height differences from top to bottom of the thin layer particle show pigment particles at all levels

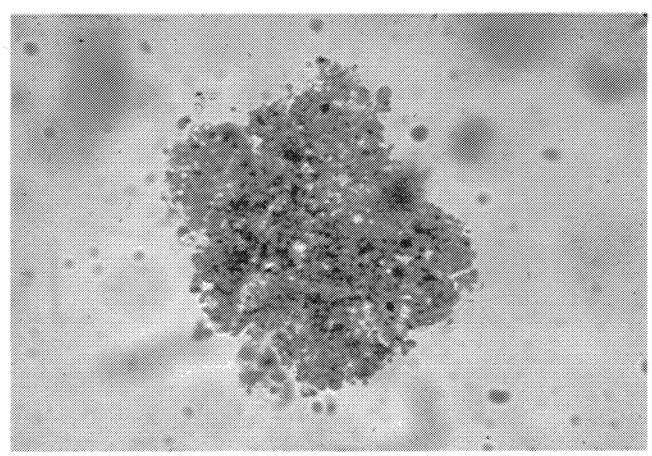

Figure 1. Vinland Map ink showing particles dispersed in a very thin gelatin film.

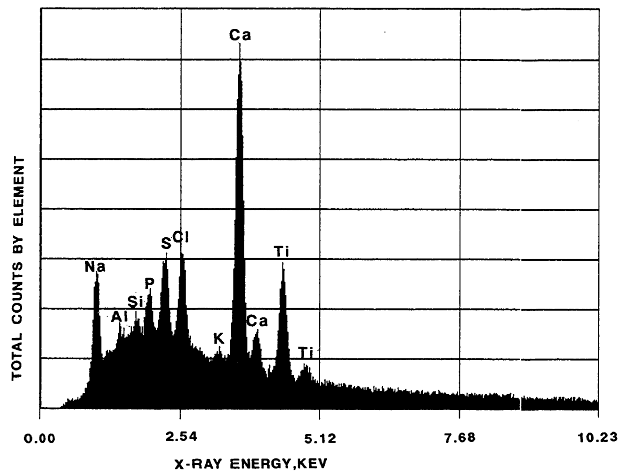

Figure 2. An SEM/EDX elemental analysis of the same yellow ink film shown in Figure 1.

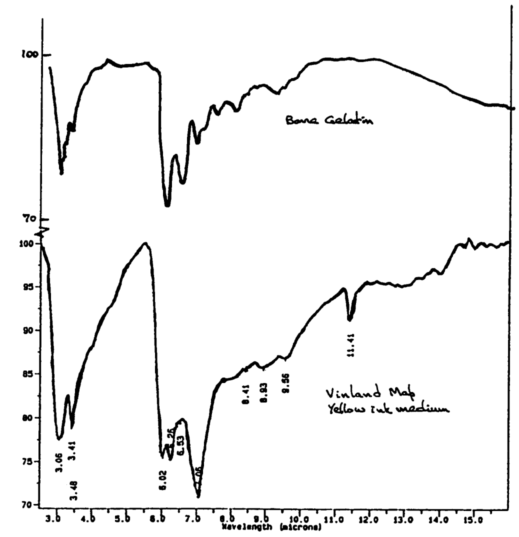

Figure 3. An FTIR/microscope absorption spectrum of a yellow ink film.

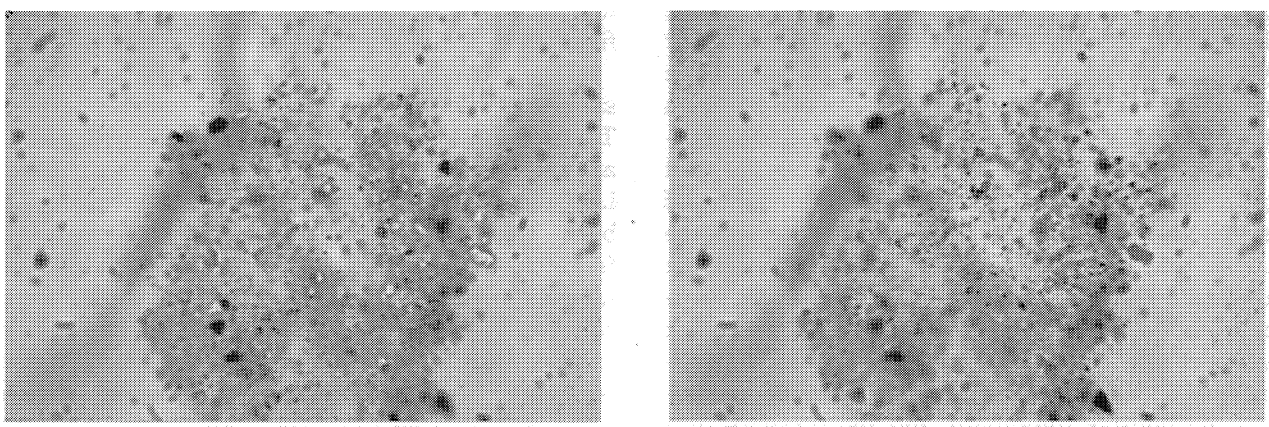

Figure 4. A second thin gelatin yellow ink film showing an upper focal level in the film (left) and a lower focal level (right) showing that the particles are dispersed throughout the film and not on the surface.

(Figure 4). If the particles were parchment fibers they would only lie on the surface of the ink film. No fiber characteristics were visible microscopically; neither by shape nor by optical properties. Parchment fibers are anisotropic (bright between crossed polars) and gelatin is isotropic (dark). Figures 1 and 4 show tiny black particles identified as titanium white. Each of these is an aggregate of hundreds of individual submicron pigment particles. Tiny particles having very high refractive indices like titanium white (average index = 2.75) appear black when viewed microscopically by transmitted light at magnifications less than about 500X. At higher magnifications (we used 1000-2500X) they can be seen to be transparent and identified as anatase rather than rutile, a more recent (1940) polymorphic TiO_2 pigment. The larger clear particles are calcite and feldspars. The fact that the particles in the film are not well-dispersed proves a lack of proper mixing and this is characteristic of "homemade" (non-commercial) inks.

This new study of the map has done two things. First, it has confirmed the double ink process and the presence of titanium white pigment reported in 1974 and, second, it has shown the medium for the yellow ink to be a collagen tempera.

The Vinland Map is still a forgery — so much for the more powerful and sophisticated analytical instrumentation available today.

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