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# Demonstration of Human Hair Follicle Biomagnetic Penetration Through Glass Barriers

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## Abstract

In previous studies of the inherent biomagnetic properties of human hair we used nano-sized iron particles for imaging electromagnetic fields (EMFs) and electromagnetic radiations, i.e., light rays emanating horizontally from the hair follicles. In the present report we tracked the follicle's biomagnetic range by its effect on crystal formation at a distance from the follicle and separated by a glass barrier. *Ex vivo* human hairs were "sandwiched" (SDW) between glass slides A second glass slide was placed over the SDW. Drops of a Prussian Blue Stain made with aliquots of a 2.5% solution of $K_4Fe_3CN_6$, 2.5% solution HCl and nano-sized (2000 mean diameter) iron particles (PBS Fe3) was applied onto the second slide over the SDW enclosed follicle. This solution was allowed to evaporate and the results recorded by video microscopy. During evaporation small crystals formed at the evaporation line until reaching the vicinity of the follicle. At this time large spike-like crystal formed as the evaporation line and these crystal reached the follicle that was 1 mm under the glass barrier. A comparison was made with a single slide preparation (SSP) of the same follicle treated similarly without the glass slide barrier. Control experiments consisted of substituting a magnet for the follicle. These findings suggest that the EMF from the follicle extends vertically at least 1 mm through a glass barrier and initiates a specific form of crystallization distinctively different than seen without the presence of the follicle or with the follicle in an SSP.

## Keywords

Biomagnetism, Vertical EMFs, Human Hair, Crystallization, Iron Particles

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## 1. Introduction

In the present report we tracked the follicle's biomagnetic range by its effect on crystal formation at a distance from the follicle and separated by a glass barrier. A comparison was made with a single slide preparation (SSP) of the same follicle treated similarly without the glass slide barrier. The study findings suggest that the EMF from the follicle extends vertically at least 1 mm through a glass barrier and initiates a specific form of crystallization distinctively different than seen without the presence of the follicle or with the follicle in an SSP. In physics, this phenomenon of how deep electromagnetic radiation can penetrate into or through a material is defined as "penetration depth" [1, 2]

The process of crystallization by evaporation consists of two stages: Nucleation, which is the first microscopic step in the crystals formation by self assembly, and secondary crystallization which is the aggregation of the small crystal into macroscopic crystalline structures [3]. In a recently published article, we used nano-sized iron (Fe) particles (having an average diameter of 2000 nm) mixed with a solution of Prussian blue stain (PBS), and applied several drops over an excised human hair follicle. Our findings demonstrated that the electromagnetic fields (EMFs) emanating from a specific area of the human hair follicle, called the dermal papilla (DP) was associated with

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crystallization when the PBS Fe 2000 solution was allowed to evaporate. Initially small crystals formed along the evaporation line. As the evaporation line approached the follicle, large crystals developed finally connecting to the dermal papilla (DP) of the follicle which contains S-100 proteins [4]. The part of the follicle, which is surgically separated from the DP when subjected to the same procedure, does not show the same crystallization response. In the present report, we intend to show that the effect of EMF on crystallization in the horizontal plane could be extended to the vertical plane by traversing a glass barrier.

# 2. Materials and Methods

## 2.1. Preparation of the Solution

A fine iron particle solution was prepared by mixing several grams of powdered iron filings (Edmond Scientific, Co., Tonawanda, NY) in 200 cc of deionized water (resistivity, 18.2 MΩ.cm). After standing for several hours the supernatant was carefully decanted for sizing of the iron nano-sized iron particles. The particle size and distribution of the nanoparticles from the supernatant was determined using dynamic light scattering (DLS) and the zeta potential using phase analysis light scattering by a Zeta potential analyzer (ZetaPALS, Brookhaven Instruments Corp, Holtsville, NY). For sizing, 1.5 ml of the solution in de-ionized water was scanned at 25°C and the values obtained in nanometers (nm). A similar aliquot of the fine iron particle solution was scanned for 25 runs at 25°C. for determining zeta potentials. Zeta potential values were displayed as millivolts (mV). A solution having paramagnetic properties was prepared by mixing aliquots of a below:

2.5% Potassium Ferricyanide solution ($K_4Fe_3CN_6$) and a 2.5% HCl. Also added were two parts of the Fe 2000 solution. The composite solution is abbreviated throughout the manuscript as "Fe3."

## 2.2. The Two Slide Preparation (1 mm Vertical Distance)

To measure the vertical magnetic penetration, a freshly plucked *ex vivo* human hair from the forearm was placed in the center of an empty slide. A whitish sticky substance (sebum) covers the follicle; this we have found facilitates the placement of the follicle on the slide. The hair was then covered *in toto* by a second slide placed on top of the first. This would bring the vertical distance from the hair to the top of the second slide to 1 mm. The slides were visually aligned and masking tape was applied at the edges to further secure the position. The Fe3 solution was then applied to the top slide, aligning the drops with the hair follicle seen within the initial glass slide sandwich. The solution was then allowed to evaporate and microphotographs and video recordings taken for further analysis.

## 2.3. The Single Slide Preparation (SSP)

Since in the "two slide preparation" the hair never came n contact with the solution, it was decided to recycle the same hair. A SSP was prepared to display the horizontal magnetic forces; the hair was placed on a clean slide (size 25 x 75 x 1mm). Two drops of the Fe3 solution covered the follicle and shaft and was then allowed to evaporate unimpeded at room temperature (77°F, 48% humidity).

## 2.4. Ancillary Comparative and Control Experiments

To simulate the putative EMF of the hair follicle, small-rubberized magnet fragments (0.8 cm long and 0.2 cm wide) were mounted as a two-slide preparation and a SSP. Drops of Fe3 were applied and the liquid allowed evaporating. These experiments were labelled controls. All preparations were photographed during (videos) or after (still photos) evaporation of the applied liquid at 10X magnification with a video microscope (Celestron LCD Digital Microscope II model #44341 Torrance California USA).

# 3. Results

When Fe3 alone was applied to a slide and the liquid evaporating, there was a random deposition of small and large crystals but no inclusion of iron particle aggregates (Figure 1). In contrast, when a magnet fragment (A in figure 2) was placed on a slide and covered with the Fe3 solution the subsequent evaporation resulted in large crystal deposition incorporating aggregated iron particles (dark material). Furthermore, the crystal surrounded and contacted the magnet itself (B in figure 2). Additional evidence of the effect of EMFs are also demonstrated in Figure 2A. In this case the magnet is at a 1 mm distance from the Fe3 solution and large and small crystals also formed.

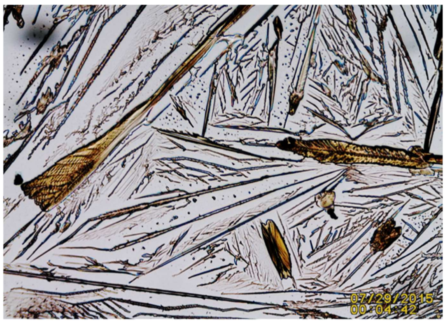


**Figure 1.** Example of control unimpeded evaporation of a SSP Fe3 solution. Notice the random deposition of small and large ferricyanide crystals with no indication of iron particles aggregates. This is attributed to the absence of any electromagnetic forces (EMFs) influencing crystals formation during evaporation.

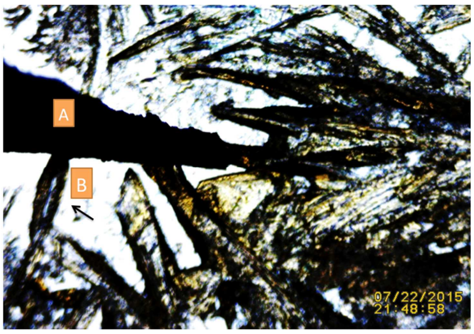


**Figure 2.** When a magnet fragment (A) was placed on a slide and covered by the F3 solution (SSP), evaporation revealed large Fe3 crystals with incorporated iron particle aggregates surrounding and contacting (B) the magnet.

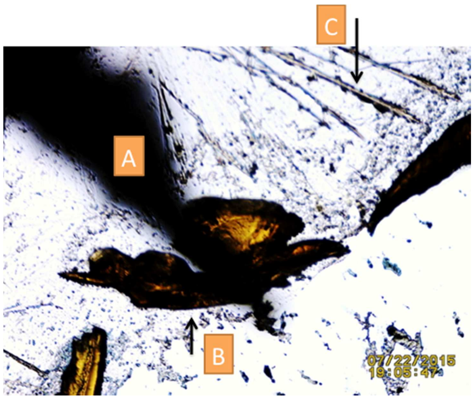


**Figure 2A.** When a magnet fragment (A) was placed in a stacked preparation the distance of 1 mm separated the magnet from the SSP Fe3 solution revealed large Fe3 crystals (B) at the latitude of the follicle. Also viewed are needle like crystals (C) attributed to the EMFs from the magnet. Please compare with Figure 4 where the vertical EMFs from the hair also triggered needle like crystals.


**Figure 3.** The forearm hair was mounted as an SSP, covered by a Fe3 solution (Fe3 in direct contact with hair).

After evaporation the hair follicle (A) was encircled by dense ferricyanaide crystals embedded with iron particle aggregates. Some of these large crystals traversed the space (B) to contact the follicle directly.

Figure 3 illustrates the similar results obtained when a human hair follicle (A) is placed in an SSP exposed to Fe3 solution. After evaporation large ferricyanide crystals (gold color B) encircle and contact the hair follicle. Due to the paramagnetic properties of these crystals heavy iron particle deposition was observed as well.

The 1mm vertical distance preparation:

Figure 4 Photograph of still frame of video # 0749. Is the stacked preparation showing the hair follicle separated by a glass barrier 1 mm distant from the applied Fe3 solution. This video shows the progressive deposition of dense crystals and iron aggregates forming along the evaporation line until encountering the putative EMF field emanating through the glass barrier. At this point, the crystals become larger and elongated eventually encompassing the virtual follicle image.

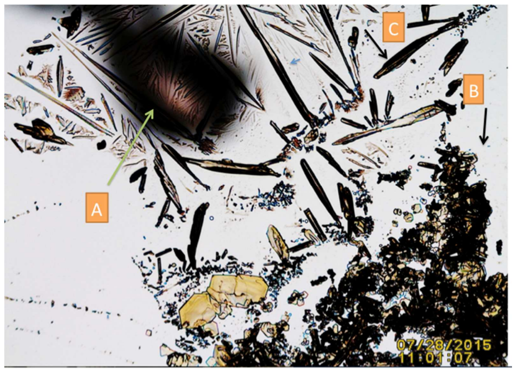


**Figure 4.** Still photograph of video frame demonstrating the EMFs penetrating a glass barrier in a SSP FE3 stacked preparation. The thickness (1 mm) of a glass slide is covering the hair A=Hair follicle (seen in a different plane) B=(Arrow) Crystallization line caused by EMFs from hair below C= Random needle like crystals. Supplementary video # 0749 (not shown) shows unequivocally the vertical idiosyncratic effect of he biomagnetic forces emitted by the human hair on the paramagnetic ferricyanide solution. There is no direct contact between the hair and the Fe3.

# 4. Discussion

Major findings:

In the present report we applied a solution containing the dissolved crystals of Potassium Ferricyanide ($K_4Fe_3CN_6$) to human hair follicles, which when the liquid evaporated, there was a distinctive form of crystal deposition observed putatively related to the EMF emitted from the follicle (Figure 3). The same experiment was performed with the untreated hair sandwiched between two glass slides and the Fe3 solution applied at a 1 mm distance from the embedded follicle. The supplementary video (not shown) initially showed dense crystals and iron aggregates forming along the evaporation line moving toward the follicle. As the evaporation line approached the follicle the crystal formation became elongated and then directly enveloped the follicle. We hypothesize that this sequence indicates that the EMF is transmitted vertically through the glass barrier (1mm thick) and reproduces the same crystallization process albeit with a longer duration (6 minutes vs. 3 minutes) seen in the SSP horizontally (figure 3).

Evidence is presented comparing and contrasting two different magnetic materials. First the *ex vivo* human hair, and second a small fragment from a rubberized magnet. Our findings add a second dimension (vertical) to where EMFs from biological (biomagnetism) samples travel. Based on our newly established findings, in a paramagnetic environment biomagnetic waves attract iron laden crystals, and the vertical biomagnetic effect on crystallization was measured to be at least 1mm or the thickness of the glass slide barrier.

We have previously reported the existence of inherent EMFs emanating from human hairs [5], rat whiskers [6] in leaves of plants [7], as well as through the exoskeleton of living gastropods [8]. In a report, the leaves of the Mung bean plant were enclosed in a slide “sandwich.” Images of the leaf edge and cells as well as structures of the leaf interior were outlined by the aggregated iron particles of the PBS Fe 2000 in the overlying slide sandwich. In the present report we are demonstrating a unique biomarker in the form of a specific form of ferricyanide crystallization in the aftermath of evaporation of the Fe3 solution in the presence of a human hair follicle.

## 5. Limitations

It could be argued that the crystallization that is reported in the present study is simply the result of evaporation, *per se* and not related to the EMF emitted by the hair follicle. Two lines of evidence mitigates against this view.

*1) In the horizontal plane:*

The characteristics of the crystallization were distinctly different in the crystal formation, i.e., dense small crystals incorporated iron particles, which initially encircled the follicle; and the later phase as the evaporation line approached the follicle, viz., large elongated crystals leading to attachment to the follicle itself (see figure 3) and

*2) In the 1 mm (glass barrier) vertical plane:*

The EMF transmitted vertically by the hair follicle across the glass barrier (see supplementary video) induced the same sequence of crystallization as seen with progressive evaporation of the same solution as shown in the control stacked magnet preparation (see figure 2A)

## 6. Conclusion

Utilizing a novel and simplified method allowing for the optical visualization of electromagnetic radiation in plant and animal tissue [9], evidence is presented confirming the existence of EMFs derived from the metabolically active human hair follicle. Also we confirmed our previously published report showing that human hair treated with a Fe3 solution shows deposition of the constituent ferricyanidne crystals induced by the inherent follicle EMF. In the present report we extended these findings by separating the hair with a glass barrier upon which the same solution was applied. After the liquid evaporated the same crystallization pattern was seen as when the solution was applied directly to the hair. We conclude that the follicle EMF penetrates the 1 mm thick glass barrier to induce a reproducible form of distinct crystallization pattern that could be attributed to distortion from the the surface resistance of the 1 mm glass slide boundary layer [10].

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