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A Question of Technique: Condition Issues Associated with Layering Structure in Richard Diebenkorn's Ocean Park Series

ABSTRACT

An examination of Richard Diebenkorn's *Ocean Park No. 111*, 1978, revealed a pattern of lifting cracks that correlated to design and/or color areas. To determine whether or not Diebenkorn's materials, his working methods or a combination of the two are responsible for the cracking, three additional Ocean Park paintings from the same time period were also examined. One exhibited similar cracking while the other two were in near perfect condition. Materials analysis was completed for all four paintings and the two paintings showing cracking were found to contain an acrylic preparatory layer. The affects of alkyd and oil paint binders on the stability of the paint films was also explored.

INTRODUCTION

This paper presents the results of a two year study of the paint application methods, materials, and associated condition issues found on Richard Diebenkorn's paintings from the Ocean Park Series. The project began when a preliminary examination of *Ocean Park No. 111* (Hirshhorn Museum and Sculpture Garden, Washington, D.C.) revealed severe cracking patterns associated with specific areas of the painting (fig. 1). Subsequent examination and analysis of the painting revealed that the artist applied a clear synthetic resin directly to his canvas support before applying an acrylic ground and multiple oil-modified alkyd paint layers. Additional Ocean Park paintings from around the same time period were examined in order to determine whether or not Diebenkorn's materials and/or his application techniques are related to the extensive cracking seen in *Ocean Park No. 111* and the severe condition issues frequently associated with many of the paintings in the series.

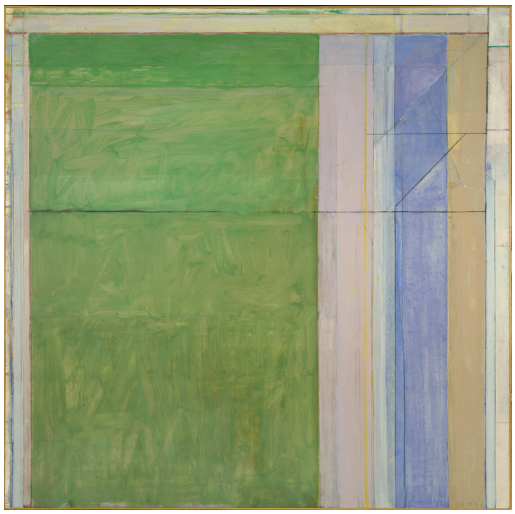

Figure 1. Richard Diebenkorn *Ocean Park No. 111*, 1978. Oil, alkyd, and charcoal on canvas, 236.5 cm x 236.9 cm, Hirshhorn Museum and Sculpture Garden.

Richard Diebenkorn (1922-1993) is recognized as one of the most important American artists in the abstract expressionist movement, as well as the leading artist of the Bay Area Figurative Movement. From 1947 to 1950 he taught at the California School of Fine Arts, San Francisco, where his fellow teachers included Elmer Bischoff and Clyfford Still. Under their influence he was drawn toward the Abstract Expressionist movement. [1] Richard Diebenkorn's Ocean Park series began late in 1967, while working in his studio in the Santa Monica Ocean Park district. The series includes about 150 paintings and was developed over the next 25 years. In the Ocean Park paintings, there is a shared emphasis on geometry and spatial relationships. The colors vary, but the paints he generally used

were airy, translucent, and brightly colored, seemingly influenced by the light and color of his surroundings.

EXAMINATION AND GROUND WORK

When *Ocean Park No.111* was requested for loan, a preliminary examination revealed an extensive system of lifting cracks that appeared to have become more severe than when the painting was last examined. Examination also revealed drips of clear polymeric resin along the tacking margins. This resinous material which the artist applied directly to the raw canvas overall and beneath the ground and paint layers is soft and malleable. Samples removed from the tacking margins are noticeably porous, as evidenced by air bubbles. Under magnification, the resin is readily visible at the bottom of crack openings and is evident in paint cross sections (fig. 2). As seen in this cross section, the resin is as thick as the combined paint and ground layers above.

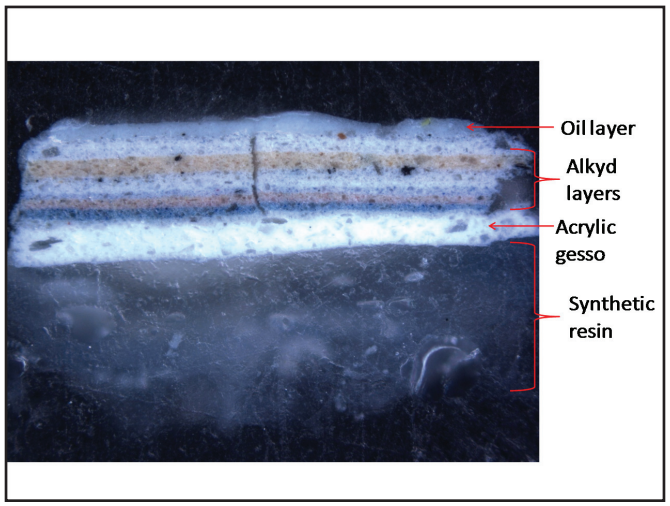

Figure 2. Cross section from *Ocean Park No. 111*. Darkfield 200x.

In an attempt to determine whether there is a correlation between the condition of *Ocean Park No. 111* and Diebenkorn's painting materials and methods of application, twelve additional Ocean Park paintings from other institutions were examined. Additionally, condition photos and treatment reports were reviewed for several other paintings of the series. Although samples were not taken from all the paintings examined, a general trend was noted. The paintings with a clear resin layer applied to the fabric support showed more severe cracking in the paint layers and were generally in poorer condition than those without it.

For the purpose of this study, the focus of the analysis was narrowed to four case studies: *Ocean Park No. 111*, 1978 (Hirshhorn Museum and Sculpture Garden), *Ocean Park No. 96*, 1977 (Solomon R. Guggenheim Museum), *Ocean Park No. 115*, 1979 (Museum of Modern Art), and *Ocean Park No. 125*, 1980 (Whitney Museum of Art). The four paintings chosen included two with severe cracking (*Ocean Park No. 111* and *Ocean Park No. 96*) and two that are in relatively good condition (*Ocean Park No. 115* and *Ocean Park No. 125*). These four paintings were also selected based on their closeness in date to remove concerns about making generalizations about condition issues of the whole series. Nonetheless, discussions and consultations with other conservators at additional institutions indicate that many of the Ocean Park paintings have varying degrees of cracking, some more distracting than others.

Case Study #1: Ocean Park No.111

Ocean Park No. 111 is executed on cream colored plain weave cotton duck canvas. The canvas is stapled and tensioned over an eight member wooden strainer. Wooden gussets are nailed into the strainer at each corner for additional support. The crossbars of the strainer, around the central square form, are smudged with paint, where the artist handled the strainer in order to turn the painting during execution. The artist applied his paints as diluted pastes, as evidenced by drying streaks and the matte, powdery surface appearance. In some areas, the paint is sufficiently thin that lower paint layers are readily visible. Also important to the design are charcoal lines drawn onto the paint surface and others that are half obscured by overlying layers of paint.

Cross sections from *Ocean Park No.111* indicate that the unpigmented resin layer described earlier was applied directly to the entire surface of the canvas, presumably as a size to protect the fabric support. Another possibility is that Diebenkorn wanted to create a smooth surface on which to work, as the resin completely masks the canvas texture. Fourier transform infrared (FTIR) analysis of a sample of the resin layer taken from a tacking margin identified it as an acrylic; specifically, a poly-ethyl acrylate-methyl methacrylate copolymer (pEA-MMA) such as Rhoplex. Rhoplex AC-33 is a likely candidate as the material was widely used by artists during the 1970s and 1980s. Figure 3 shows the spectra of a sample from *Ocean Park No. 111* compared to that of Neocryl BT-20, a bulk pEA-MMA resin. The shape of the C-H stretch region, around 2800-3100 cm^{-1}, is an indication of an acrylic resin, as is the location of the carbonyl peak at 1732 cm^{-1} and the shape of the fingerprint region. Pyrolysis-Gas-Chromatography–Mass

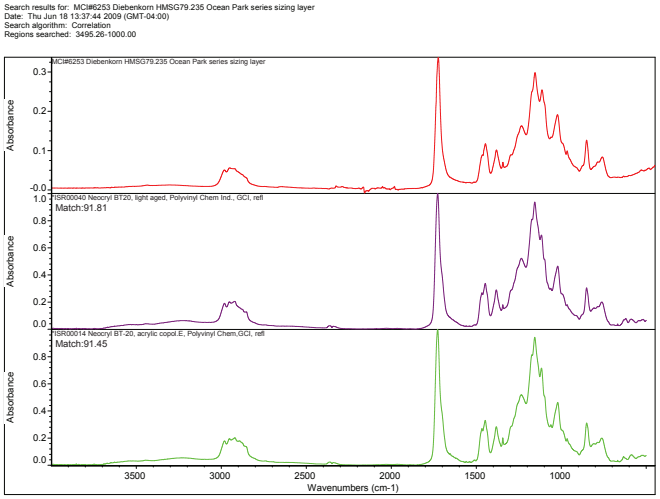

Figure 3. Comparison of the FTIR spectrum for the clear synthetic material in *Ocean Park No. 111* and two spectra for bulk ethyl acrylate methyl methacrylate acrylic emulsion (Neocryl BT-20 from DSM NeoResins).

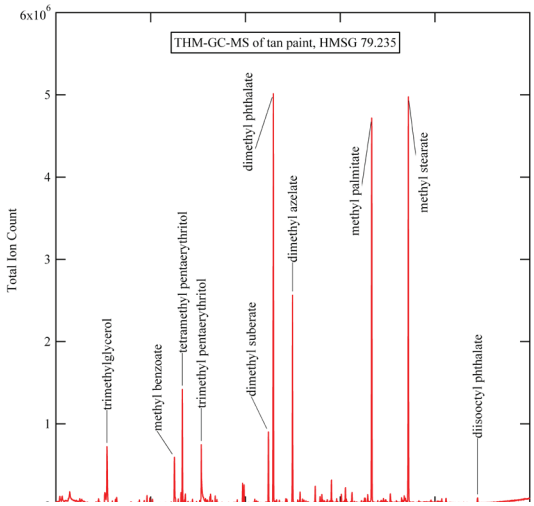

Figure 4. Pyrogram for a sample of tan paint taken from the surface of *Ocean Park No. 111* with the characteristic peaks noted.

Spectrometry (Py-GC-MS) verified the identification of the sample as a pEA-MMA resin.

Diebenkorn next applied a white ground directly to the synthetic resin layer. FTIR analysis and Py-GC-MS identified the ground medium as an acrylic resin (pEA-MMA). The homogenous dispersion of the pigments, the identification of the filler material (chalk and kaolin), and the fact that the ground does not extend onto the tacking edges suggest that this is a commercial priming that the artist applied himself.

FTIR and Py-GC-MS analysis identified the paints that Diebenkorn used as oil-modified alkyds. Peaks identifying the pentaerythritol backbone of an alkyd are clearly visible in the pyrogram from a sample of the tan paint taken from the surface of the painting (fig. 4). In several of the paint samples identified as alkyd paints, there also seems to be a peak at ~1160 cm^{-1} that suggests there is some free oil as part of the paint composition that may indicate an added artist's oil medium or paint. Additionally, the identification of pigments and the absence of filler materials characteristic of alkyds indicate that the artist occasionally alternated alkyd paint layers with artists' oil paints.

The surface of *Ocean Park No. 111* is riddled with a complex network of cracking patterns (fig. 5). There are extensive linear cracks located at the corners of the painting. Additionally, isolated areas of branched crackle are associated with specific

Figure 5. Detail of *Ocean Park No. 111*, raking light, upper right quadrant.

color areas and appear to correlate with changes that the artist made to his composition. For example, near the center of the left side of the painting there is an isolated rectangular area of cracking within the larger green area (fig.6). This seems to be associated with a design area that the artist scraped and subsequently reworked. Also visible is a system of distracting rounded cracks with cupped edges that extend along the left side of the painting. These cracks appear to coincide with vertical charcoal lines on the paint surface as well as charcoal lines that are concealed beneath the upper paint layers (fig. 7). Under magnification, additional smaller cracks and fissures can be seen in close proximity to these larger rounded cracks.

Figure 6. Detail of *Ocean Park No. 111*, raking light, left edge, center.

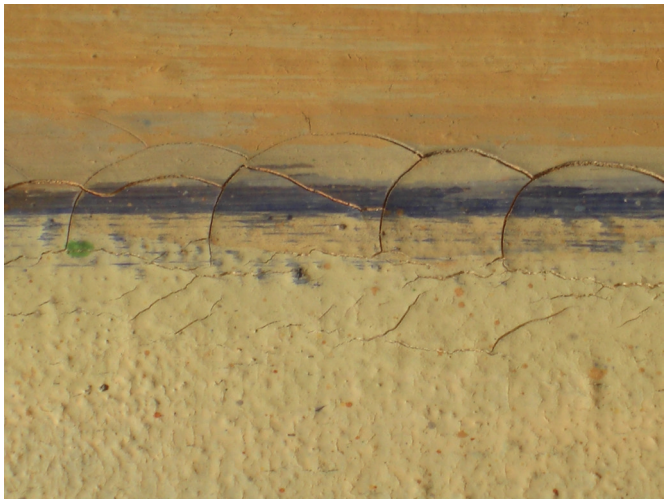

Figure 7. Cracking related to drawing on dry paint in *Ocean Park No. 111*, detail, along left edge.

Both cracking patterns appear to propagate from charcoal lines in the composition and were likely caused when the artist drew with charcoal into already dried paint layers. Diebenkorn was known to have worked on his paintings over long periods of time, sometimes repainting entire surfaces (Bernstein 2009).

Case Study #2: Ocean Park No. 96

Ocean Park No. 96, 1977, was painted a year before *Ocean Park No. 111* and exhibits many of the same condition issues. According to early examination reports, both paintings exhibited cracking less than two years following their completion. The cracking patterns in both *Ocean Park No. 96* and *Ocean Park No. 111*, show localized areas of dense cracking associated with reworked design areas and areas along drawn charcoal lines (fig.8).

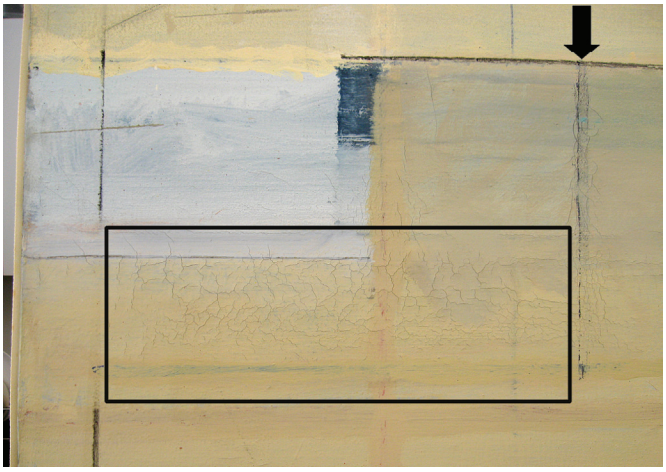

Figure 8. Detail of *Ocean Park No. 96* in an area exhibiting both widespread cracking and cracking following a drawn line as indicated by the square and arrow.

As is the case in *Ocean Park No.111*, a clear resin material is visible as drips on the tacking margin and at the base of the cracks. A section of the composition left unpainted along the bottom edge also reveals this layer. The band retains the color of the raw canvas, a feature which Diebenkorn is known to have appreciated because of its neutral tonality (Larson 1977). FTIR analysis of the paint in *Ocean Park No. 96* revealed that they are oil-based alkyds similar to those found in *Ocean Park No. 111*. Rather than an acrylic gesso ground, *Ocean Park No. 96* has a preliminary white paint layer over the clear resin size, presumably an alkyd paint, although a sample was not available for analysis. The artist applied this white layer selectively to areas of the canvas that were painted.

Two cross sections were taken from the blue square located in the upper left quadrant of the design, half of which exhibited cracking and half of which did not. One sample was taken from each half. In both cross sections, the unpigmented acrylic resin layer is clearly visible and is as thick as, or thicker than, the combined thickness of the overlying paints layers. Significantly, the cross section taken from the half that exhibits cracking reveals a surprising buildup of paint layers measuring almost 83 μm thick (fig. 9a). The cross section from the non-cracking portion contains only 2-3 layers of paint and measures less than 50 μm in thickness (fig. 9b). Moreover, several of the individual paint layers in Figure 9a measure less than 10

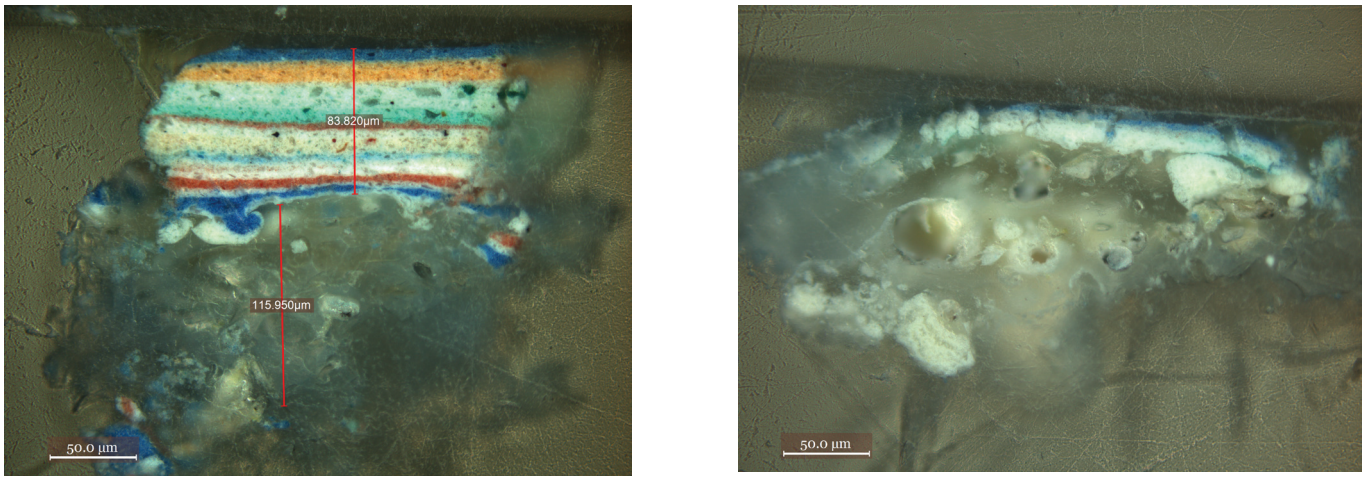

Figure 9. Comparison of two cross sections from *Ocean Park No. 96*, 200x, darkfield. The cross section on the left (a) was taken from an area that exhibited cracking while the section on the section on the right (b) was taken from an area that did not.

µm thick, which suggests that the artist diluted his paints to an almost wash-like consistency before applying them. As seen in *Ocean Park No. 111*, the filler content in both of these cross sections is consistent with a commercial paint, probably an oil-based alkyd. The difference between these two samples seems to indicate that artist layering and manipulation of his paint may play a large role in how much cracking occurs. Inconsistency of thickness in some of the thinner layers also suggests that the artist scraped down his paints once they were applied.

Case study #3: ocean park no. 115

Ocean Park No. 115, 1979, is in good condition and does not exhibit the widespread areas of cracking seen in the previous two case studies. The only cracking evident correlates with charcoal lines drawn into the surface along the top half of the painting. *Ocean Park No. 115* is executed on a commercially primed canvas, as the priming is evenly applied and extends to the ends of the tacking margins. It was again identified as an acrylic gesso ground. The paints were identified by FTIR as oil-based alkyds. Significantly, the painting does not have the synthetic resin preparatory layer identified in *Ocean Park No. 111* and *Ocean Park No. 96*. Otherwise, the painting materials in this work are similar to the previous case studies: oil-based alkyd and oil paints over acrylic grounds. Likewise, all three have similar exhibition histories.

Case Study #4: Ocean Park No. 125

Though painted only two years after *Ocean Park No. 111*, *Ocean Park No. 125* is in excellent condition. As with *Ocean Park No. 115*, cross sections revealed that there is no acrylic resin size present. The paint layers are exceptionally thin and alkyd use is very likely based on appearance and comparison of the paints to the cross sections of *Nos. 111, 115* and *96* where the medium was identified.

COMPARISON OF MATERIALS

The unpigmented acrylic resin size layers found in both *Ocean Park No. 111* and *Ocean Park No. 96* were compared using FTIR. Figure 10 shows their spectra compared to aged Rhoplex AC-33. As shown, the three materials share the same characteristic peaks. Furthermore, samples of the resin size material taken from two additional Ocean Park paintings were identified as poly(ethyl acrylate-methyl methacrylate).[2]

The grounds of *Ocean Park Nos. 111*, *115*, and *125* were all identified as acrylic gesso. Figure 11 shows their comparative spectra. Interestingly, the grounds of *Ocean Park No. 115* and *Ocean Park No. 125* were commercially primed while that of *Ocean Park No. 111* is an acrylic that the artist applied by hand based on the fact that the ground does not extend over the tacking margins. As mentioned previously, the preliminary white paint layer from *Ocean Park No. 96* is probably an oil-based alkyd based on pigment and filler composition.

FTIR analysis indicates that Diebenkorn's paints in all four works are predominantly oil-based alkyds, although isolated layers of drying oils were also identified. Figure 12 is a

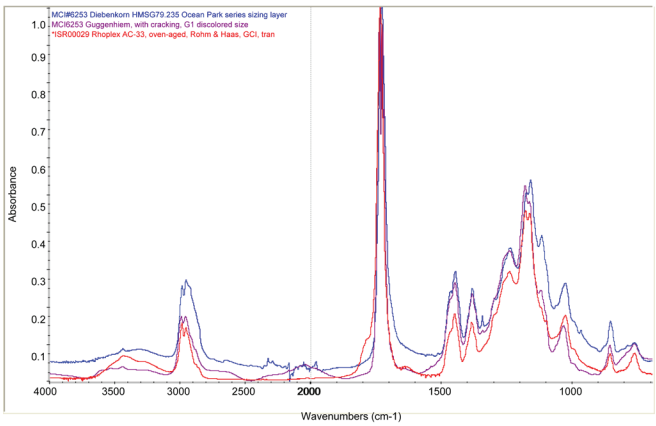

Figure 10. Comparison of FTIR spectra for the synthetic preparatory material from *Ocean Park No. 111* and *Ocean Park No. 96* to aged Rhoplex AC-33.

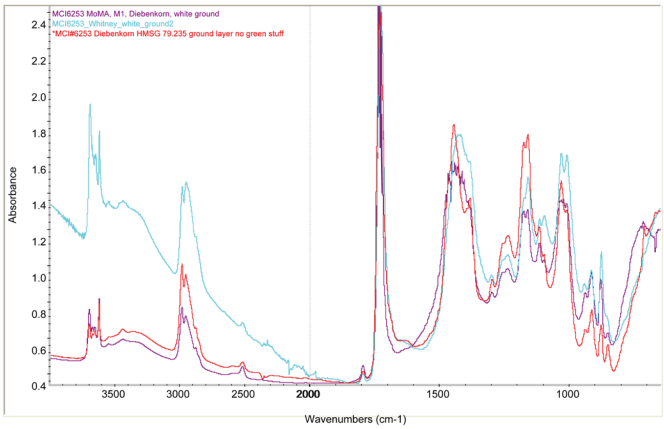

Figure 11. FTIR spectra for ground samples from *Ocean Park Nos. 111, 115,* and *125*. The comparison illustrates the similarities of the acrylic ground layer in the three paintings.

comparison of the FTIR spectra of paint samples from *Ocean Park Nos. 111*, *115*, and *96*. All three show a broad peak from 1260-1280 cm^{-1}, typical of alkyd paint binder (Ploeger, Scalarone and Chiantore 2008). The alkyd peak at between 1260 through 1280 cm^{-1} in the spectrum of a paint sample from *Ocean Park No. 96* is partially obscured by the large calcite peak. Very small peaks or shoulders were visible in a number of the paint samples from the three paintings at 1600 and 1582 cm^{-1}, indicating the presence of phthalates, one of the components of an alkyd paint. The location of the carbonyl peak at 1732 cm^{-1} instead of 1740 cm^{-1} for oil based paint found in all of the spectra is also indicative of an alkyd binder. Py-GC-MS analysis of four samples from *Ocean Park No. 111* confirmed the presence of oil-based alkyd paint.

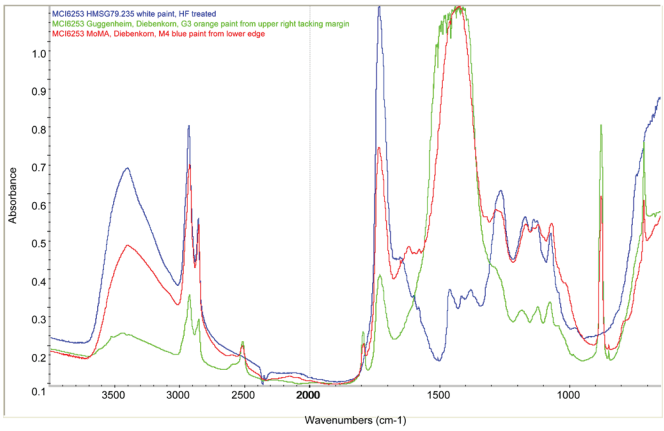

Figure 12. FTIR spectra of alkyd paint samples from *Ocean Park Nos. 111, 115,* and *96*.

PROBLEMS ASSOCIATED WITH ALKYD USE

Diebenkorn's use of oil-based alkyds and his methods of applying them may have contributed to the condition issues associated with many of the Ocean Park paintings. Oil-modified alkyds form stiffer and stronger paint films than do traditional drying oils due to the polyester backbone of the polymer. The molecular weight of an alkyd is much higher than that of traditional drying oils so fewer cross links are required for stable film formation, causing the binding medium to harden to the touch between 18 and 24 hours after application (Ploeger 2009). The artist may have found this quality appealing and selected these paints, in part, because they dry faster than artists' oils. Diebenkorn's use of fast-drying and relatively brittle paints combined with his practice of scraping down and drawing through them with charcoal at later stages in the painting process likely contributed to the cracking reported just two years after *Ocean Park No. 111* and *Ocean Park No. 96* were executed. Alkyd paints have also been found to become increasingly stiff with age (Ploeger 2009). Additionally, Ploeger found that the continuation of the oxidation processes in alkyd paint after film formation is complete might also lead to the deterioration of the film. With age, excessive cross linking may occur, causing the alkyd paint films to become still more stiff and brittle.

Diebenkorn's practice of heavily diluting his alkyd paints with solvents may also have had an effect on the overall stability of

paint layers. Commercial alkyds are formulated for application to architectural structures and are meant to be applied directly from the can. Changing the formulation has the potential to adversely impact the integrity the paint. Evaporation of solvents from the alkyd paint creates a porous, under bound paint film that further contributes to the overall brittleness of the paint layer. With excessive dilution, a two phase structure forms instead of a cohesive layer, with the pigments favoring one phase over the other (Croll 2009). Additionally, much of the binder may have leached out of the uppermost layers, causing the powdery, matte surface characteristic of these paintings. Solvent loss during drying also has the potential to cause internal drying stresses (Whitmore et al. 1999). This results in paint layers under tension that are more prone to failure from additional stresses during handling, environmental responses, or further aging.

The cross section illustrated in Figure 2 may be indicative of what is happening structurally to the Ocean Park paintings that are in poorer condition. An internal vertical fissure is visible through the center of the sample. Significantly, the alkyd paint layers have cracked preferentially to the oil paint layer on the surface and the acrylic gesso layer beneath. Many of the cracks now visible on the surface of these paintings may have started in the alkyd paints and with time migrated to the softer artist's oil and ground layers. Moreover, it is likely that the inherent flexibility of the acrylic size layer would have magnified any stresses placed on the paint layers, causing smaller fissures and flaws in the brittle alkyds to propagate to the surface and into the ground. As previously noted, the paint layers in most of the cross sections from *Ocean Park No. 111* and *Ocean Park No. 96* measure about 100 microns on average, while the clear synthetic resin of both paintings is twice as thick. In these examples, brittle and excessively lean alkyd paints were applied to a heavy layer of flexible resin size that provides inadequate support. Moreover, Rhoplex has been found to maintain rubbery flow over many years (Michalski 1991). This potentially means a longer period of vulnerability these paintings might experience. With any cause of stress whether it be mechanical or environmental, and little resistance from the support, cracks form freely and propagate. A particularly interesting study by Young et al. (2006) found that alkyd paint layered over an acrylic gesso increased the overall stiffness of samples and caused premature failure of the acrylic during stress tests. These paintings illustrate this in a real, natural setting.

POSSIBLE PIGMENT EFFECT

Zinc was identified in *Ocean Park No. 111* within isolated layers of the white and green oil paints. It has been observed that the presence of zinc in paint layers has the potential to increase brittleness and cause structural failure (Mecklenburg, Tumosa, and Erhard 2005). In their study, paint layers over zinc grounds were found to crack preferentially compared to paint layers over lead grounds. A more recent study by Mecklenburg also suggests that zinc ions in an isolated paint layer can migrate to surrounding paint layers, increasing brittleness and changing mechanical properties (Mecklenburg, Tumosa, and Vicenzi 2010). As zinc was identified in isolated layers of drying oil across *Ocean Park No. 111*, it is possible that zinc may be affecting the stability of surrounding paint layers. As mentioned, the alkyd paints become progressively more rigid over time and the addition of zinc magnifies this effect.

CONCLUSION

A comparison of the materials and paint structures in two Ocean Park paintings by Richard Diebenkorn in good condition with two more extensively cracked paintings shows that those with alkyd paints applied over the synthetic resin show greater evidence of cracking than those that did not have the resin layer. While there may be other factors that have contributed to the condition issues evident in these paintings, this study indicates that the artist's practice of applying brittle paints over a rubbery, flexible support is a recipe for cracking. The relatively elastic nature of the synthetic size is poorly suited as a support for the extremely brittle alkyd paint and layering methods employed by Diebenkorn. Localized areas of dense cracking associated with specific design elements likely occurred when the artist scraped down and drew into already dried painting layers. While heavy paint build-up and scraping away of paints are techniques seen in Ocean Park paintings with no condition issues, the presence of the unpigmented resin size in combination with an inherently brittle paint magnifies the adverse effects.

Future work may include formulating a conservative treatment proposal and establishing preventative measures to protect against further cracking. At this time it is recommended that handling and traveling is limited. The effect of zinc ion migration on surrounding paint layers is currently being studied.

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ENDNOTES

1. http://www.diebenkorn.org/bio/bio.html. From the RD Biography. © 2010 The Estate of Richard Diebenkorn.
2. These were *Ocean Park No. 66.*, 1973, (Albright Knox Art Gallery in Buffalo, New York), and *Ocean Park No. 83,*1975, (Corcoran Gallery of Art in Washington, D.C.)

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