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Astro-Photography

Stages of Photographic Development
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The pictures presented here show stages in the development of III a-J and II a-O emulsions using different exposure intensities, developers and times of development. Previous investigations were made with transmission electron microscopes (TEMs).

Therefore it was necessary to remove the whole gelatine and to make replicas of the grain surfaces or thin cuts (30 nm) of the layer. In the latter case the probes heat up and the crystals melt because of the high current of the TEM. The pictures shown here were obtained with a scanning electron microscope (SEM). Thus the fragile silver grains could be preserved and kept in their original environment. The current of the probe is low, no noticeable thermal deformation of the crystals occurs (East 1983)

The surfaces of the probes are seen predominantly through secondary electrons, while the deeper parts of the emulsion are imaged by backscattered primary electrons. The maximum resolution of the OEM is about 5 to 10 nm. All images shown here are enlarged by a factor of 2600 times Preparation. All plates were exposed for 10 seconds. The development was stopped abruptly with acetic acid. The plates were washed under running water. No fixing was used, because this way one can compare developed and undeveloped grains. The upper layer of the emulsion was removed with the enzyme trypsin. After washing for a second time the plates were airdried. Finally all plates were sputtered with gold (about 100 nm) to prevent electrostatic charging. After stopping the development, all preparations and observations were done in roomlight. It has been shown that this has no visible effect on the silver halide grains (East 1983).

Identification and Elimination of Plate Flaws in Copying
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1. INTRODUCTION

Since it came into operation in 1973 the UK 1.2m Schmidt Telescope (UKST) has taken nearly 12,000 wide field photographs of the Southern Sky. Many of these plates were taken for a Sky Survey and the precision copies for world-wide distribution, on both film and glass, have been made in Australia, at ESO, and, since 1978 at the Royal Observatory, Edinburgh. In order that the maximum amount of information can be transferred from original plate to final copy with the minimum introduction of flaws or spurious images, meticulously maintained clean rooms are essential for the copying procedure. Unfortunately, even in the best managed darkrooms, problems do occur; this paper will illustrate some of the problems encountered at ROE and, where possible, the solutions found.

2. COPYING PROCEDURE

The original plate is placed emulsion down on a holding frame. The back of the plate is carefully cleaned with a solution of 10% ammonia and 90% isopropanol. It is then placed emulsion up on the base of a vacuum exposure frame. Under red safelight conditions, the emulsion is inspected by grazing white torchlight and particles of dust and other remaining undesirables are removed, often with difficulty. A process plate is then removed from its packaging, blasted with compressed air, and inspected as carefully as possible under a safelight. If any problems, such as blobs of gelatin or minute glass particles on the emulsion surface, are detected and cannot be easily removed the process plate is rejected at this stage. The process plate is then laid in contact with the original (emulsion to emulsion), the lid of the exposure frame lowered over the plates, and vacuum created. Once a firm laminate has been established the frame is raised to a vertical position for exposure to the UV transmitting light source situated at the end of a light tunnel. After exposure the frame is returned to a horizontal position, vacuum is released, and the plates are separated; the copy being loaded into a handling frame for processing. Exactly the same procedure is used to make a glass negative copy with the original plate being replaced by the master positive. The processing procedure has been described several times (e.g. West 1978, Standen and Tritton 1979) and will not be repeated here other than to say that the targets for the final negative are a gamma of 1.0 and central density of 0.5.

3. QUALITY CONTROL

Other than to check for obvious "foreign bodies" embedded in the surface of the emulsion it is very difficult to quality control the positive plates. However, the negative copies are subjected to a rigorous quality control procedure. Each plate is carefully checked for any introduced large scale phenomena, such as processing marks which could be mistaken for real nebulosity. The plate is then scanned under a microscope at 40x magnification in a grid pattern at intervals of about 25mm. This enables a variety of flaws, if present, to be detected. Examples of such flaws are shown in Figures 1-5. Many of these flaws are very obvious even to the untrained eye and are unlikely, by themselves to be confused with real objects. Objects in this category include the halo images (Fig 1a), the white holes (Fig 2a) and the scuff marks (Fig 5). However, these can affect the overall quality of the copy plate and must, wherever possible, be avoided. The false stars (Fig 2b) can often be easily detected as these images are

Figure 1. (a) shows out of focus halo images which result from microscopically small deposits on the back of the positive. (b) shows halos and streaks which result from larger areas of dirt and grease also on the back of the positive.

Figure 2. (a) shows in-focus spots resulting from the deposits in the emulsion of the positive. (b) shows false stars - tiny hard black images resulting from particles adhering to the emulsion of the original processing.

Small and sharp; they are, therefore, most serious on the best quality plates where they can resemble the faintest stars and objective prisms plates where they can appear as spurious emission lines. Probably the most serious problem is defocusing which can often be extremely hard to detect; in some cases (Fig 3 a) a chip of glass can cause serious but fairly localised

Figure 3. (a) shows a glass chip embedded in the emulsion and causing localised defocussing. (b) shows an emulsion tear also causing defocussing .

Figure 4. The same area of sky from four glass negatives all taken from the same positive. (a) as original. (b) a lump of gelatine on the glass negative causes local defocussing. (c) the lump has transferred to the positive affecting the subsequent negative. (d) after removal of the lump a faint dark patch is seen on the negative.

Figure 5. "Scuff marks" result from physical damage to the emulsion surface of the positive. Slight defocussing is also present.

defocussing but in others much larger areas of slight defocussing can only be detected by recognising that the images of the photographic grains are less sharp than they should be. All these problems are most serious when the plates are measured and analysed by machine; in particular the defocussing may result in the failure of star/galaxy separation routines.

4. IDENTIFICATION OF CAUSES AND ELIMINATION OF THE FLAWS

Problems in copying can be divided into two main groups; in about 80% of the cases where the source is visible and 20% where no source can be seen. The latter category includes defocussing due to poor vacuum contact and due to unevenness in the surface of the glass; these problems are resolved by making a further copy. The identifiable sources of flaws can be further subdivided into those found on the emulsion surface of the copy or the original and those which occur on the back (glass side) of the original. The word "original" is taken to mean the master from which the copy is made and will therefore actually be a positive in most cases. At ROE we discovered that tiny halo images on copies resulted from microscopically small deposits on the back of and often concentrated in areas around the edges of the original. On the copy these deposits produce small out of focus "ghost" images (Fig 1a).

The solution is to increase the dosage of plate cleaner on the back of the original at the preparation stage, allowing the fluid to sit on the glass and dissolve the particles. Rubbing the plate firmly completes the removal of the deposit. The more obvious streaks (Fig 1b) result from larger areas of dirt on the back of the original. Flaws found on the emulsion surface can be harder to eliminate. Particles of glass embedded in the emulsion can cause a large area of the copy to be out of focus (Fig 1c). If the offending body is on the copy a new copy can be made. However if the problem is on the positive then a new positive must first be made. If the problem is on the original the particle must be removed, possibly by using a scalpel blade. In the worst cases the original may be too badly damaged for use as an atlas master plate. In rare cases, it is impossible to remove the body; this again means the rejection of the original as it is not possible to produce in-focus copies. Other undesirable particles include small lumps of gelatin introduced during manufacture; these can cause defocussed areas leading to the rejection of the copy. In some cases the gelatin particle transfers during the copying process from the copy to the original, thereby affecting later copies made from that original. Even after the removal of the particle evidence of its presence remains in the form of a faint dark patch on later copies (Fig 4). The white holes (Fig 2a) appear to result from an opaque deposit on the surface of the emulsion; these "gum spots" are difficult, if not impossible, to remove and may cause rejection of the original. The last example of flaws on the emulsion is seen in Fig 2b, the false stars. These appear to be small

particles which adhere to the original during processing. In some cases, rewashing the original has solved the problem, but in others the problem was severe enough to cause rejection. The scuff marks (Fig 5) come from actual damage to the emulsion surface. Incorrect handling or storage of positive plates resulted in pressure marks appearing on the emulsion surface. It appears that the seams of the tyvek envelopes, or labels stuck on the envelope can cause this damage. Oddly enough, such damage has never been detected at ROE on original plates although many positives have been affected. The storage procedures for positives have been modified to minimise this damage.

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