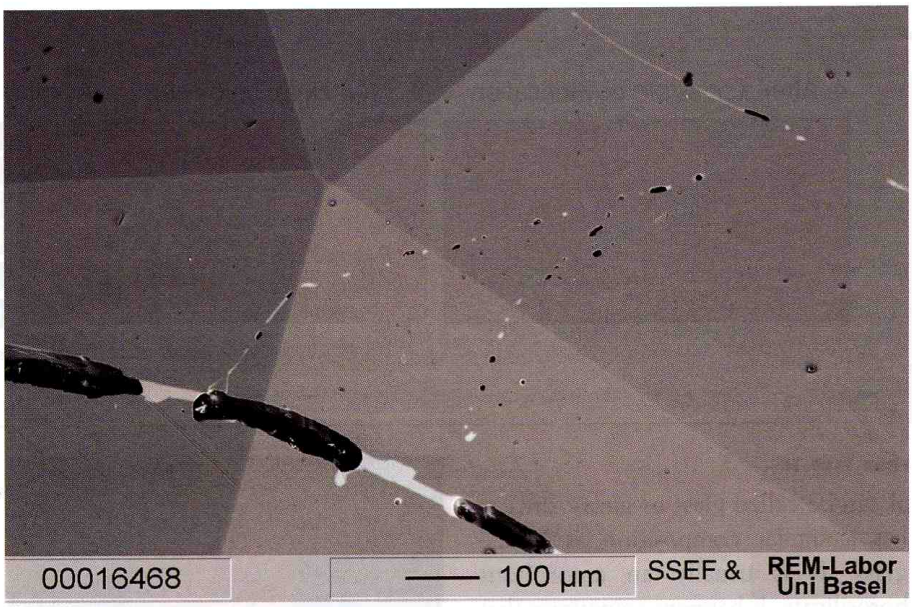
Ruby heat treatment and fracture repair

When applied to rubies together with heat treatment under controlled atmosphere, flux-like substances, including borates, are able to heal fissures and fractures of the gemstones, according to director of the SSEF Swiss Gemmological Institute in Basel, Switzerland, Professor Henry Hanni. More rough rubies have undergone this form of artificial healing before being polished, he said. The following is the abstract of Professor Hanni's presentation on ruby heat treatment and the healing of fractures and fissures during the 2001 Gem-related Jewellery Technology Conference which will be held in Hong Kong from Tuesday, November 13, to Thursday, November 15, 2001.

By Professor Henry Hanni of SSEF Swiss Gemmological Institute



SEM Laboratory of Basel University in Basel, Switzerland

Scanning electron microscopic (SEM) picture of a heat-treated ruby with glassy flux residues (bright) and gas and shrinking bubbles (black). The traces of the former fissures are clearly visible, also the newly formed portions of (synthetic) corundum between the glassy residues. Width of the picture is approximately 1.5 mm

The main treatment applied to ruby is heat under controlled atmosphere, or with the addition of a melt on its surface. There are three aims that can be reached by a heat treatment:

- a shift of the colour (reductive or oxidative heating),
- an increase of transparency (e.g. by dissolving rutile silk nests), and
- an increase of mechanical stability (artificial healing of fissures with flux)

Heat alone can transform the initial colour to a more pure red when there is a hue of purple or brown in the stone. Where oxidation or reduction of the iron provides the colour transition, typically temperatures between 1,200 degrees Celsius and 1,800 degrees Celsius are involved. Under such high temperatures, inclusions are damaged or even dissolved, a fact that allows us to identify the thermal treatment by a microscopic investigation. With turbid stones the dissolution of rutile silk by heat treatment usually improves the clarity of rubies.

SUBSTANCE: HEAT TREATMENT WITH FOREIGN SUBSTANCES

During the same heat treatment, fissures and fractures can become healed when a flux-like substance is added to the stone. Borates or fluorides such as borax or cryolite are used for such measures. The molten compound flows over the surface of the stone and is drawn into the openings by capillarity.

It is important to understand the very important effect such an artificial healing has on the stones. Whereas in former times rough stones have been knocked and cleaned and then bruted, today a large volume of rough stones is heated before this process. The result is that all the pores and fissures have soaked the glassy melt or flux, and that the melt is kept deep in the former fissures. The fissure planes are recrystallized and show now the same "fingerprint" patterns as stones with naturally healed fissures. The newly developed portions of ruby or walls within the fissure plane may be called synthetic ruby since they are produced by human intervention.

The difference however is that the artificially healed stones contain foreign residual material from the "flux" used as seen in the figure. This materi-

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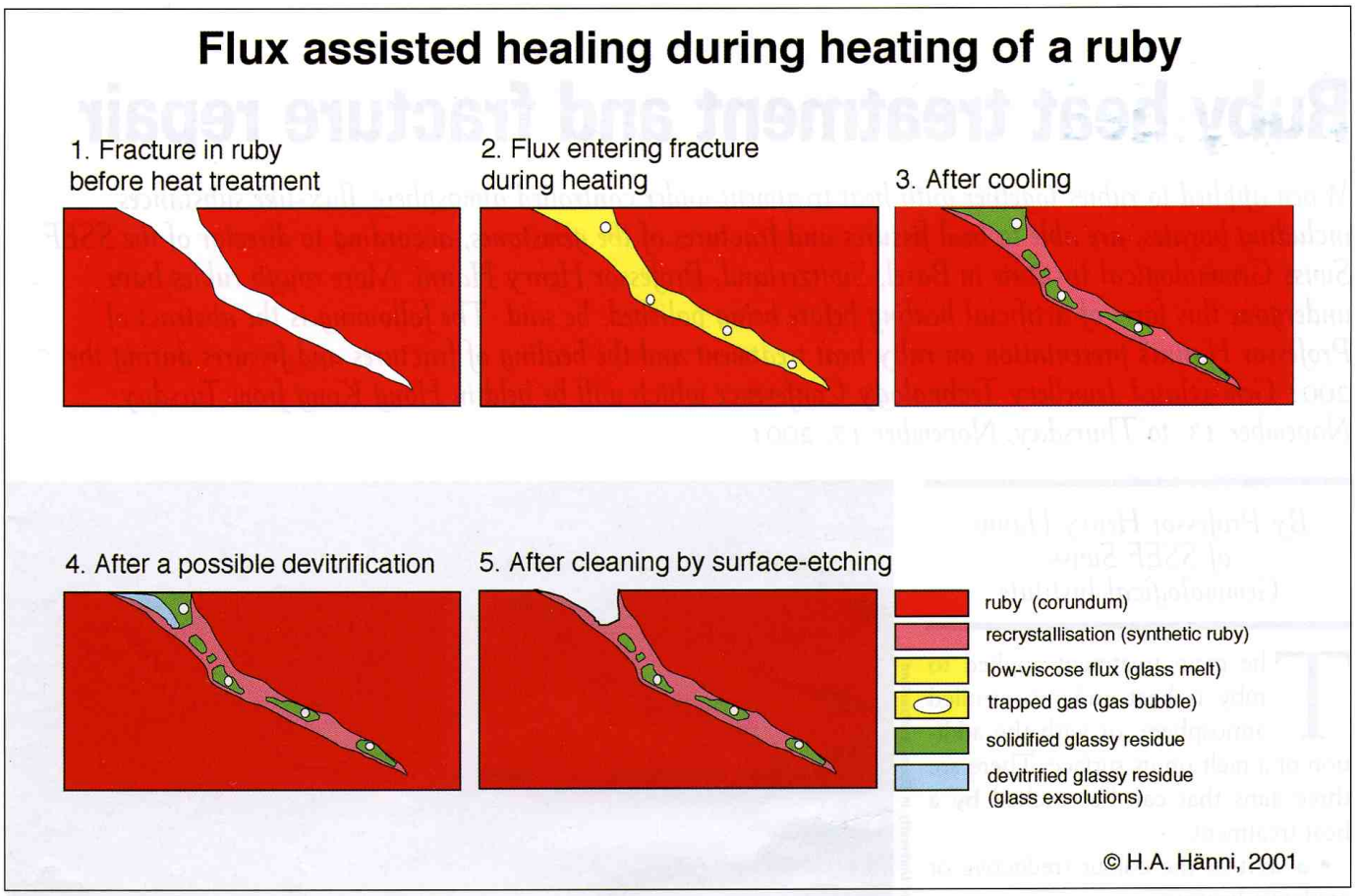

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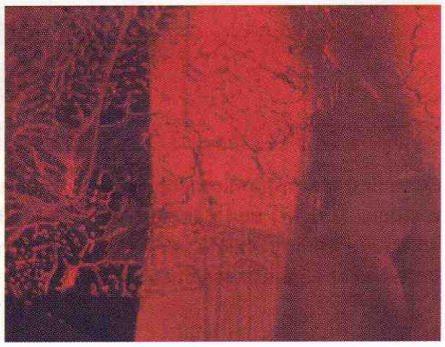
al can be called glass or glassy since it has a similar composition as borate glass. It is usually an amorphous borosilicate. It happens sometimes that within the residual glassy droplets kept in the fissures, crystallisation of radiating fibers takes place. The glass thus partially devitrifies, and in a great deal of heat and glass-treated stones we can recognise whitish arrays of such formations. The centres of the arrays usually contain a spherical void. The Diagrams above explain the progressive steps that a ruby may run through during a heat treatment with support of a glassy melt.

Henry Hanni, SSEF

A heat-treated ruby of 2.5 carats with a significant crack that is healed under flux conditions. Glassy flux residues are kept in channels, the areas between the residues are re-crystallised during the treatment



Henry Hanni, SSEF

Healed fissure in a heat-treated ruby under flux conditions. The picture reminds a flux synthetic ruby. However, the stone is natural, only the contents of the channels and network are artificial. The inclusions extend on the former fissure plane, which is now healed to a large extent. Magnification approximately 30 times

When the glassy substance is on the surface of a stone, it can be dissolved with hydrofluoric acid (HF). It is however not possible to remove the glassy substance out of the spaces behind the newly formed ruby walls since HF does not dissolve corundum. It depends on the standards of the gemmological laboratories how they express the situation where more or less of the foreign material is present in a stone. The most recent standards of SSEF Swiss Gemmological Institute apply the following expressions for heated rubies with glassy residues: With indications of thermal enhancement and artificial glassy residues in fissures. Among of residue: minor, moderate or significant.