３）掛軸装の安定化処理および保存修理

調査診断

救出された陸前高田市立博物館所蔵掛軸装の調査および安定化処置を実施しました。調査によって、被災資料は一応乾燥し室内で保管されていたもの、湿ったままの状態で保管されていたもの、冷凍保管されていたものの３つに分類することができました。言うまでもなく上記資料は海水をはじめとする様々な汚染物質を含んでおり、真菌や細菌の繁殖によって相当に劣化が進んでいました。塩分などの除去と乾燥処理を含む、劣化を抑制するための安定化処置を行うことが不可欠な状態にありました。また、多くの資料は収蔵品としての資料情報を失っていて、仮目録の作成が必要でした。そこで調査資料に「仮整理番号」を付し、その番号によって一連の処理を進めました。

選別（トリアージ）

調査の結果、救出された資料は掛軸装の拓本などを中心に400件を超えました。安定化処理および修理対象とする作品を効率的に処置するために､「損傷」「汚染」「料紙」「支持体」「法量」を資料選別の項目として設定のうえ調査診断し、資料選別しました。分類された資料群ごとに中性紙保存箱に保管し、作業に備えました。

処理方針

処理対象とした資料の多くは掛軸装に仕立てられていて、資料の伝来と地域の歴史を後世に伝える重要な資料でした。そこで、表装を解体するか否かを検討しなければならず、作業工程の策定はその点を考慮に入れ慎重に行われました。最終的に、表装を解体し本紙に十分な脱塩処理を行う方法で安定化処理を実施することにしました。

資材・場所

2011 ～ 2012年の作業に当たっては、脱塩処理作業に必要な資材の手配とともに実施場所の確保に奔走しました。処置作業場所と一時保管場所を備え、理想的には安定した環境を維持できる設備を求めていたところ、奥州市埋蔵文化財調査センターのご厚意で作業場所を提供していただき、調査室の一角を処理作業場に仕立てることができました。並行してNPO文化財保存支援機構（NPO-JCP）に人員の確保を要請し、全国各地の作業技術者が集う体制を構築しました。

2014年の作業は、岩手県立博物館敷地内に設置された、仮設陸前高田市立博物館被災文化財保存修復施設２階を使い、東京国立博物館指導の下、NPO-JCPのスタッフによって作業が進められました。

安定化処理

難易度が高く、多岐に渡る作業を含む工程です。安定化処理は以下の２つの工程に分けられます。中でも脱塩処置を確実に施すことが今回の安定化処理における重要な課題です。

3) Stabilization and Repair of Hanging Scrolls

Survey and diagnosis

We analyzed and stabilized the salvaged hanging scrolls, or artwork and various documents that had been turned into hanging scrolls. They were originally stored at the Rikuzentakata City Museum (hereinafter referred to as “RTCM”). Based on the results of the analysis, it was found that the disaster-damaged materials could be divided into the following three categories: those that were dried by some sort of method and were stored indoors, those that were stored in a damp state, and those that were stored in a freezer. Obviously, the analyzed items contained various contaminants including seawater, and had considerably advanced degradation due to the proliferation of fungi and bacteria. The salvaged materials were in urgent need of degradation suppression and stabilization, including drying and removal of salt and other contaminants. In addition, since the information for their identification as museum collection items was lost for most of the assets, a temporary catalog had to be prepared. The surveyed items were given “temporary reference numbers,” and the series of treatment was performed according to these numbers.

Selection (triage)

As a result of the survey, it was found that more than 400 items which primarily consisted of rubbings of stone inscriptions and other paper-based works made into hanging scrolls had been salvaged. In order to efficiently treat the salvaged materials to be stabilized and repaired, the items were surveyed and diagnosed for sorting after setting up the following five sorting categories: “damaged,” “contaminated,” “paper,” “supporting medium” and “size.” The sorted materials were placed in preservation boxes made of acid-free paper and stored in category-based groups in preparation for the treatment.

Treatment strategy

Most of the artwork and documents selected for treatment had been turned into hanging scrolls and were important materials which had been and would continue to pass on the legacy of the items and local history to succeeding generations. Thus, it was necessary to evaluate whether or not to disassemble the mounting material. Taking this point into consideration, the treatment process was carefully formulated. Ultimately, it was decided to perform stabilization by employing a method that enabled sufficient desalination of the primary documents and works of art by disassembling the mounting material.

Treatment materials and workspace

For the treatments performed during 2011 and 2012, considerable effort had to be put forth to procure the materials required for desalination and to acquire the space to adequately perform the desalination process. We had been looking for a facility equipped with a treatment workplace, temporary storage space and, ideally, a place where a stable environment could be maintained. Eventually, we were given a generous offer from the Oshu City Buried Cultural Property Research Center. The Center allowed us to use their facility as a temporary workspace, and we were able to set up a treatment workspace in the corner of the Center’s research room. At the same time, we requested that the Incorporated NPO Japan Conservation Project (NPO-JCP) could be provided with restoration experts. With this, we were able to build a system consisting of experts that gathered to work on this treatment project from across Japan.

The restoration efforts in 2014 were performed by the NPO-JCP staff under the guidance of the Tokyo National Museum. This was done on the second floor of the temporary

図1　安定化処置作業風景（奥州市埋蔵文化財調査センター内）
Fig. 1　Staff performing stabilization (at a workspace in the Oshu City Buried Cultural Property Research Center)

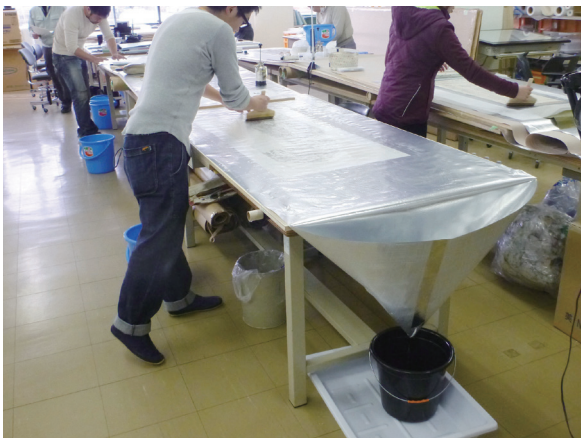

図2　防湿アルミシートを用いて処理を行い、排液を貯水槽に捕集した。
Fig. 2　Collecting discharged liquid into the storage tank using moisture-proof aluminum sheets

図3　処置前の状態調査（拓本掛軸／K-87-9）
作品の状態から巻かれた状態で被災したとわかる。
Fig. 3　Pre-treatment condition survey (hanging scroll)
The condition of the artifact demonstrates that it was damaged by the disaster in a rolled-up state.

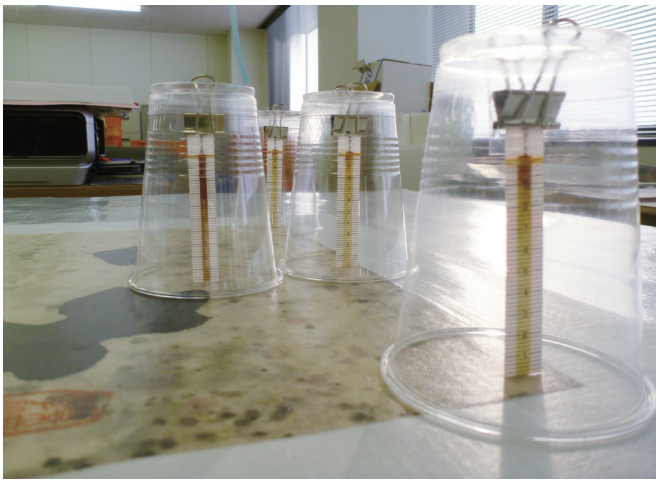

図4　掛軸装の塩分測定（拓本掛軸／K-87-9）
Fig. 4　Measuring the salinity of a hanging scroll

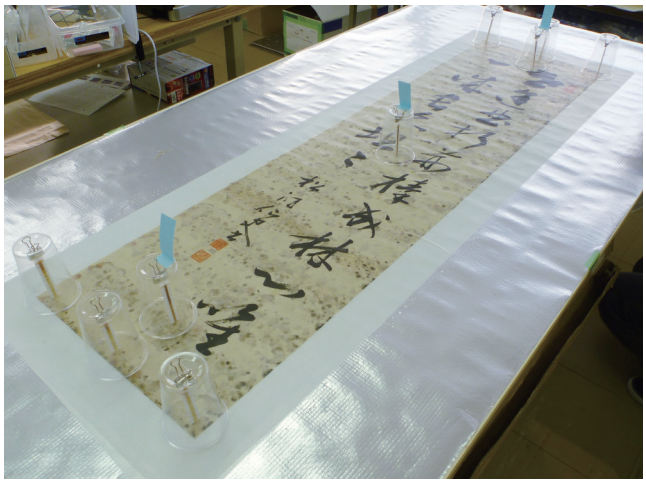

図5　同左
Fig. 5　Measuring the salinity of a hanging scroll

掛軸装の被災状態と塩分濃度の関係を検証した。（拓本掛軸/K-87-9）
　本紙上中下の7箇所について計測した。
　本紙上部①：カビの多い部分　塩化物試験紙（HACH）による調査結果
　処置前 本紙右上部①（High Range）：NaCl 0.890%、Cl^- 5402ppm（mg/L）
　処置前 本紙右下部⑤（High Range）：NaCl 0.529%、Cl^- 3207ppm（mg/L）
　処置後 本紙右上部①（Low Range）：NaCl 0.009%、Cl^- 54ppm（mg/L）

The relationship between the conditions of the disaster-caused damage and the salinity was verified. (Hanging scroll of an inscription rubbing/K-87-9)
　Seven points at the top, middle and bottom of the inscription rubbing were measured.
　Top of the rubbing: area with substantial mold growth
　Results of an examination using chloride test slips (HACH)
　Pre-treatment　Upper right of the rubbing (High Range): NaCl 0.890%, Cl- 5,402ppm (mg/L)
　Pre-treatment　Lower right of the rubbing (High Range): NaCl 0.529%, Cl- 3,207ppm (mg/L)
　Post-treatment　Upper right of the rubbing (Low Range): NaCl 0.009%, Cl- 54ppm (mg/L)

安定化処理１＝（解体→養生→加湿→脱塩処置）
安定化処理２＝（乾燥→記録）

掛軸装の被災状態と塩分濃度の関係

数点の資料について脱塩処理中に塩化物濃度を測定するための試験紙を各部位へ設置し、塩分濃度分布を調べました。その結果、掛軸外縁と本紙を含め相当量のカビが多く発生していた箇所は高濃度を示しました。また、本紙横方向に等間隔で高濃度を示す領域が分布する資料も数多くみられました。巻かれた状態で海水に浸った場合、資料表面から内部に海水が浸透するため、掛軸外縁は必然的に高濃度となります。また、海水に浸っていた時間が長い箇所ほど、高濃度を示し、その部分に多量の不純物が固着し、乾燥後再び湿気を帯びる関係で、カビが発生していた箇所で高い値が観測されたものと推定しています。

拓本や墨書など紙本作品の脱塩処置方法

表装を解体し本紙と肌裏紙のみとなった資料の表裏を、機能紙（ポリエステル紙、レーヨン紙、サンモア紙）で養生し、機能紙の上から噴霧器や刷毛で水道水を少しずつ含浸しました。汚染物質と共に溶出した塩分を排水する脱塩処理を行いました。さらに水道水を表面あるいは裏面から加え、刷毛で排水することで脱塩を行いました。当初は毎回生じる排液をビーカーで捕集し、排液量を計測した後、電気伝導率計を使って含有される塩分濃度を計測しました。作業は作品の状態保全を最優先に進め、排液の塩分濃度（NaCl）が「処理に用いた水道水の数値である0.01％」と同じ値に到達するまで繰り返しました。

測定の結果、処理回数と時間は資料や作業者にほとんど依存せず、概ね５回で完了できることが確認されました。そこで、以降はすべての資料について塩分濃度確認を行わず、定期的な確認に留めることとしました。

紙本墨書の作品の脱塩処理方法

2014年7月から8月にかけて岩手県立博物館内仮設陸前高田市立博物館被災文化財保存修復施設において、紙本墨書の本紙脱塩処理作業を行いました。先ず、先に述べた方法で資料の本紙表裏を機能紙で養生しました。次に、資料ごとに脱塩処理に用いる水道水および精製水を一定量秤量し、使用しました。準備した脱塩液を40 ～ 50℃に加熱し噴霧器に入れ、機能紙の上から加湿しました。資料に精製水を十分に浸み込ませた後、刷毛を使って除去しました。

ビーカーに刷毛で取り除いた水溶液を捕集し、液量を計測し、塩素イオンメーターで含有される塩化物イオン濃度（Cl^-）を測定しました。捕集した液の塩化物イオン濃度が6ppm（目標値を6ppmにしましたが、処理液の水道水に含まれる塩化物イオン濃度が日により変動するため、実際は1 ppmの誤差を設定）以下になるまで脱塩処理を継続しました。

脱塩処理開始当初の排液は黄色く濁っていて、多量の

preservation and restoration facility for disaster-damaged cultural assets from the RTCM that had been set up on the premises of the IPMM.

Stabilization

The stabilization process is highly technical and involves a wide variety of treatments. It is divided into the two treatments shown below. The most important goal for this particular stabilization project was to perform complete desalination.

Stabilization treatment 1: (Disassembly → Curing → Humidification → Desalination)

Stabilization treatment 2: (Drying → Recording)

Relationship between the conditions of the disaster-caused damages and salinity of the hanging scrolls

In order to measure the chloride concentration of the salvaged materials while performing desalination on a small number of items, test paper was placed at various locations on each item to record the salinity concentration distribution. The results demonstrated that concentration was high in places both on the primary documents and works of art and on the outer borders of the hanging scrolls where mold had grown considerably. In addition, the high concentration areas in the lateral direction were distributed at equal intervals on the main paper-based work. This was observed on many items. Hanging scrolls that were soaked in seawater in a rolled-up condition naturally have high chloride concentrations at the outer borders since seawater soaks in from the surface of the items towards the interior. Concentrations were higher in places that had been soaked in the seawater comparatively longer. It is assumed that concentrations were higher in places where mold had grown because impurities were affixed to places soaked in seawater for a long duration and because the salvaged materials had become damp again after they were dried.

Desalination method for paper assets

After disassembling the mounting materials, the front and back of the works on paper and the linings were cured using high-performance paper (polyester paper, rayon paper and *Sanmoa* paper of SANWA SEISHI Co. Ltd. [See p.101]). Then, tap water was slowly allowed to soak in from above the high-performance paper using an atomizer and a large brush. In the method we employed, salt was removed by discharging the liquid into which the salt eluted together with the contaminants. More tap water was added to the front or back side for further desalination by discharging the liquid using a large brush. Initially, the discharged liquid was collected in a beaker after each treatment. Then, after measuring its volume, the salinity of the discharged water was measured using an electrical conductivity-measuring device. While performing the treatment, the highest priority was placed on conserving the condition of the assets. Treatment was repeatedly performed until the salinity (NaCl) of the discharged liquid reached a value equivalent to the salinity of the tap water used for the treatment, i.e., “0.01%.”

The analysis revealed that the number of treatments and the time required for the treatment did not depend on the salvaged materials or the individual staff members, and that desalination was completed usually after performing 5 treatments. Thus, after a result was obtained, a salinity check was not performed on all items but only on a few items as a periodic salinity check.

Desalination method for writings in ink on paper

During July and August 2014, desalination of matted works written in ink on paper was performed, excluding the matting material, at the temporary preservation and restoration facility for disaster-damaged cultural assets of the RTCM at the IPMM. First, the front and back sides of the works on paper were cured with the previously described method using high-performance

不純物が含まれていたものと推定されます。捕集液の塩化物イオン濃度が30ppm程度になった段階から目標値である6ppmまで低減させるのに要する時間と脱塩処理回数は、本紙の状態によって異なりました。そこで今回は、すべての資料の排液について塩化物イオン濃度測定を行いました。

展示に向けて抜本的修理（掛軸装）

ほとんどの作品の安定化処理を終えたところで、やがて再建される陸前高田市立博物館における展示に活用可能な状態にするために、安定化処理を終えた本紙を順に掛軸装に仕立てる修理を行いました。本紙は脱塩処置の際に洗浄されており、本紙料紙に負担をかける恐れのあるシミの除去などの措置は基本的に行わないこととし、本紙の風合いを損なわないよう修理を進めることに留意しました。また、修理材料は、保存性を考慮し小麦粉澱粉糊や楮紙など安全性が証明されている伝統的材料を使用しました。

鈴木晴彦（東京藝術大学非常勤講師、東洋絵画書跡保存修復士）

paper. Then, tap water and purified water were measured to prescribed amounts for each item, and used as a treatment. The prepared desalination liquid was poured into an atomizer after warming it up to 40 - 50°C, and sprayed from above the high-performance paper. After the purified water had soaked into the materials sufficiently, the liquid was removed using a large brush.

The liquid removed was put into a beaker, and its volume was measured. The concentration of chloride ion (Cl^-) contained in the liquid was measured by a chloride ion meter. Desalination treatment was continued until the chloride ion concentration of the collected liquid reached 6 ppm or less (though the target value was set at 6 ppm, in reality variance of 1 ppm was allowed since the chloride ion concentration in the tap water fluctuated depending on the day the treatment was performed).

The discharged liquid from the initial desalination treatment was murky and yellow, leading to the assumption that the liquid contained large amounts of impurities. The time and number of treatment required for reducing the chloride ion concentration from a stage where it had reached approximately 30 ppm to the target value of 6 ppm depended on the conditions of the paper assets. Thus, for this treatment, the chloride ion concentration of the discharged liquid was measured for all items.

Fundamental repair in preparation for display

When we had reached a point where most of the works had been stabilized, we began repair measures to turn the stabilized works on paper into hanging scrolls to restore them to a displayable condition for proper utilization at the RTCM, which will eventually be rebuilt. Since the works on paper were washed during the desalination process, it was decided that, in principle, treatments such as stain removal which may damage the paper of the assets should not be performed. The papers were converted into hanging scrolls while attempting to preserve the texture of the works to the maximum extent. Moreover, traditional materials which have proven to be safe, such as flour starch glue and *kozo* (mulberry) paper, were used for the repair work considering their ability to preserve the assets.

Haruhiko Suzuki (Tokyo University of the Arts part-time teacher / Conservator of oriental painting and calligraphy)

図6　電気伝導率計（塩分濃度計測）（TOKO, CT-27112B型）
Fig. 6　Electrical conductivity-measuring device (salinity measurement) : TOKO CT-27112B

図7　塩化物試験紙　（HACH, 左／ Low Range, 右／ High Range）
Fig. 7　Chloride test slip: HACH, Left / Low Range, Right / High Range

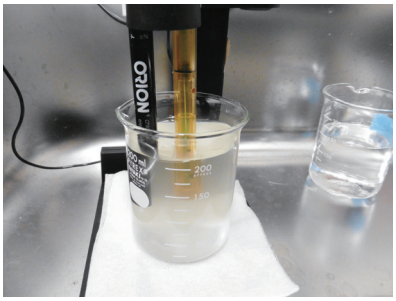

図8　塩化物イオン濃度 水質計（ORION, model 900A）
Fig. 8　Chloride ion concentration, water quality meter: ORION model 900A

図9　塩化物イオン濃度 水質計（TOKO, TiN-51021）
Fig. 9　Chloride ion concentration, water quality meter: TOKO TiN-5102i