

以前，莫高窟的保护操作专注于实际的修复，较少注意壁画病害的成因。结果，20世纪70年代已经治理过的一些病害，如起甲和地仗层空鼓有复发的现象并导致了进一步的劣化与脱落。

因此，对保护材料与病害治理的研究及测试成为本保护项目的主要内容。

In the past, conservation practice focused on repair rather than addressing the causes of deterioration. Consequently, some conditions such as flaking and plaster detachment of the wall paintings—both previously treated in the 1970s—recurred causing progressive deterioration and loss.

As a result, research and testing of appropriate conservation materials and treatments became a large part of the project.



在病害治理前仔细检查每个区域。  
Each area was carefully examined before treatment.



所有的区域在治理前后都有记录并且建立档案。  
All areas were documented before and after treatment.



用注射器将浓度1-2%的明胶溶液注入起甲的壁画层，使之重新粘结。  
Flaking paint was readhered with a 1-2% gelatin solution injected with a syringe.



使用木质工具（图示）或丝绸包裹的软球体轻柔地将起甲的壁画压回原位。  
The paint flakes were then gently pressed back into place using a wooden tool (shown) or a soft silk covered ball.



正在主室东壁进行保护工作。  
Conservation work in progress on the east wall of the main chamber.

## 研究与测试 Research and Testing

根据所了解的病害成因和机理，遵循最小干预、相容性和可再处理的原则，对85窟进行了保护干预。选择与配置保护材料并且对其进行严格的测试，以评估其性能。

Conservation interventions followed the principles of minimal intervention, compatibility, and retreatability and were based on knowledge of the causes and mechanisms of deterioration. Treatment materials were selected and formulated and then rigorously tested to evaluate their performance.



第85窟筛选出来的灌浆材料包括本地清洗过的粘土、玻璃微珠(Scotchlite K1®)、碾碎过的浮石、搅拌好的蛋清和蒸馏水。  
The adhesive grout formulated for Cave 85 included local washed clay, glass microspheres (Scotchlite K1®), crushed pumice, whipped egg white and distilled water.



对整窟大面积的壁画层进行了灌浆处理。  
Large areas of painted plaster were injected with the grout mixture throughout the cave.



使用注射器和导管在壁画层后进行灌浆处理。  
Injection of the grout mixture behind the painted plaster was done using syringes and catheter tubes.



在灌浆之后，立即用有吸水能力的顶板顶住壁画一直到灌浆材料干燥为止。这一关键步骤减低了含水灌浆材料所造成的可溶盐运移并且避免盐分在壁画表面结晶。  
Immediately after grouting an absorbent press was applied and kept in place as the grout dried. This key step reduced soluble salts mobilized by water in the grout which would crystallize on the surface of the wall painting.

## 实施保护措施 Treatment Implementation

第85窟的主要治理措施包括灌浆：用灌浆材料重新粘合已经与砂砾岩层分离的壁画地仗层，并且使用一种明胶溶液加固起甲的颜料层。改进壁画保护所用的材料与工艺是本项目的一个主要目标。

Principal remedial treatments in Cave 85 included grouting—the reattachment of separated plaster from the rock conglomerate with an adhesive grout—and fixing of flaking paint with a gelatin solution. Improving the techniques and materials for conserving wall paintings on earthen plasters was a major aim of the project.



治理后的窟顶西披。没有对脱落的区域重绘，最大限度地添加新的地仗泥层，以避免人为增加水分（来自潮湿的地仗层），因为水分会造成可溶盐在壁画层内运移。保留了早期保护工作中对地仗层的修复区域以及近年来因壁画脱落使砾岩裸露的区域（如1996年脱落的区域）。  
The west ceiling slope after conservation treatment. Areas of loss were not repainted and new plastering was kept to a minimum in order to avoid the addition of water (from the wet plaster) which could redistribute soluble salts within the painted plaster. Instead, plaster repairs from earlier conservation work were left in place and recent areas of loss (such as the area of collapse from 1996) were left unfilled with the conglomerate exposed.



在筛选出加固壁画层的灌浆材料之前在实验室内对 80 多种不同配比的灌浆材料进行测试。  
More than 80 different grout mixtures were tested in the laboratory before a material was selected to reattach areas of painted plaster.



在第85窟内四壁下部的砂砾岩层（没有颜料层的区域）上粘结新的模拟地仗试块进行灌浆材料试验。  
Testing of grout mixtures was undertaken in Cave 85 at the base of walls (in unpainted areas) by adhering modern plaster panels to the conglomerate.