A STUDY ON THE CLEANING METHODS OF STONE ARTIFACTS

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Paper presented at
The Second Asia Fellows Program Annual Conference
on "Globalizing Asia: Shifting Identities and Continuity"

Bangkok, Thailand, July 1-2, 2002

Introduction

Stone has been one of the earliest materials used by man since prehistoric times to make tools, implements and art objects. In recent times, these stone artifacts have formed a large part of the collections in museums, temples, churches, and homes of private collectors. Stone artifacts, though strong and durable, disintegrate in time due to various deteriorating factors such as heat, the presence of micro-organisms, salts, algae, water, acids, dust, stains and mishandling.

Cleaning of stone artifacts is often necessary and is usually done to improve its aesthetic appeal and to prevent it from deterioration. There is a considerable large number of stone cleaning methods known in the field of conservation today such as washing, mechanical cleaning, chemical cleaning and special methods of cavitations, lasers, and poultices (Ashurst 1990, Mansfield 1988). Cleaning of stone artifacts, however, should only be carried out after taking into consideration the possible losses that could be caused by cleaning, against the deterioration associated with leaving the dirt or foreign matter alone (Ashurst 1990:125). When one decides to clean the artifacts, care and attention should be taken to use the best methods available. This is because cleaning of stone artifacts often involves some risks and incorrect methods of cleaning can and have caused irreparable damages to the stone artifacts. The selection of the most effective methods of cleaning stone artifacts is therefore very important in order to produce the best results and to prevent the stone artifacts from further deterioration.

Stone artifacts made of marble, sandstone and granite often suffered from deterioration due to the accumulation or presence of foreign matters such as soot, oil, paint and algae. Deposits of soot, oil, paint or algae are not only ugly, imparting a black, greenish or other color appearances on the stone artifact, they may also fill cracks, open joints or obscure areas of deterioration. Their presence may also produce pits and alter the surface of the stone, thereby weakening the structure of the stone artifact. As such, soot, oil, paint or algae often need to be cleaned and removed from stone artifacts made of marble, sandstone or granite. As discussed earlier, cleaning of soot, oil, paint or algae should be carried out with care, especially if the cleaning process involves the use of chemicals. Prior to the cleaning process, however, a survey of cleaning tests to clean soot, oil, paint or algae should be done first to determine the risks and to find the best possible methods. The survey of cleaning tests should first be done on small test areas of the artifacts. But sometimes, the small size and the fragile conditions of stone artifacts often do not allow for such a survey of cleaning tests to be carried out directly on the artifacts. In such cases, the survey of cleaning tests should be done using similar rock samples stained with soot, oil, paint or algae.

The aim of this paper is to compare methods commonly used to clean soot, oil, paint and algae from stone artifacts made of marble, granite, and sandstone. The study hopes to compare the effectiveness of these different methods in order to determine the possible risks that might occur and to find the best methods for cleaning soot, oil, paint, and algae from stone artifacts made of marble, granite and sandstone.

Materials and Methods

Three rock samples of marble, granite and sandstone were used for the cleaning tests: (i) white marble from Rajasthan, (ii) black granite from Rajnagar village in Bangalore, and (iii) red sandstone from Lucknow These rock samples were obtained from a commercial tile shop in Lucknow, India. The rock samples were cut into similar sizes, each measuring about 3 inches long x 2 inches wide x 0.5 inches thick. A total of 21 rock samples were stained completely with a thin layer of soot and oil obtained from Castrol oil using a wick while another set of 9 rock samples were stained with a thin layer of red enamel paint. Cleaning tests were then done for 5 minutes and 15 minutes on these rock samples stained with soot, oil, and paint using methods commonly used today. Cleaning tests on algae were carried out on a small area of the algae-colonized sandstone walls of INTACH office in Lucknow. The following cleaning tests were carried out:

Test 1: Cleaning of soot on marble, granite and sandstone using

(i) 0.5% Labolene (neutral detergent) in lukewarm water with cotton swab sticks

(ii) water with cotton swab sticks

(iii) 5% dichloromethane in ethanol with cotton swab sticks

(iv) ammonia:water:hydrogen peroxide (1:1:1 ratio) with cotton swab sticks

(v) AB57 solution with cotton swab sticks

(vi) AB57 solution with Carboxyl Methyl Cellulose (CMC) poultice

(vii) AB57 solution with Nepalese tissue pulp poultice

(viii) AB57 solution with Fullers' earth poultice

Test 2: Cleaning of red enamel paint on marble, granite and sandstone using

(i) dichloromethane (methylene chloride) with cotton swab sticks

(ii) dichloromethane (methylene chloride) with Fullers' earth poultice

(iii) ethyl alcohol with cotton swab sticks

Test 3: Cleaning of algae from the sandstone walls using

(i) 0.5% Labolene with a soft toothbrush

(ii) ammonia:water (1:10 ratio) with a soft toothbrush

(iii) AB57 solution with a soft toothbrush

(iv) bezalkonium chloride with a soft toothbrush

The AB57 solution was prepared using the standard established mixture of water (100ml), ammonium bicarbonate (3 g), sodium bicarbonate (5 g), disodium salt of EDTA (2.5 g) and 10% of Labolene solution (1 ml). The carboxyl methyl cellulose (CMC) poultice was prepared by dissolving CMC in AB57 solution with constant stirring until a thick paste is obtained. The paper pulp poultice was prepared using Nepalese tissue pulp soaked in AB57 solution. The Fullers' earth poultice was prepared by adding powdered Fullers' earth in AB57 solution until a thick paste is obtained. The CMC poultice, Nepalese tissue paper poultice and Fullers' earth poultice were each applied onto the surface of the rock samples at a thickness of about 3-4 mm and left for 72 hours. The poultices were all covered with a polythene sheet to slow done the rate of evaporation of AB57 solution or dichloromethane and to allow more time for the poultices to absorb and to clean the soot, paint or algae stains from the stone artifacts.

Results and Discussions

The following discusses the results of the cleaning tests carried out in this study. The details of the results are given in appendices 1-12.

(1) Cleaning of Soot

Soot can be easily cleaned and removed from granite, sandstone and marble (as in order) using 0.5% Labolene in warm water. After 15 minutes of cleaning with 0.5% Labolene in warm water, soot and oil stains were removed almost completely from granite but not from the sandstone and marble surfaces. The soot and oil stains left on the surfaces of the stone artifacts made them appeared darker in color than the original. Water alone could also remove soot easily from marble, granite and sandstone (as in order) but water was not as effective as 0.5% Labolene in warm water. Oil stains was more difficult to remove with water alone and water was much less effective in removing oil stains compared to 0.5% Labolene in warm water.

5% dichloromethane in ethanol was effective in cleaning soot and oil stains on marble and granite surfaces but it was less effective on sandstone because soot and oil tend to get stuck to the pores of the sandstone surface. The mixture of ammonium: water: hydrogen peroxide (1:1:1 ratio) was very good for removing soot and oil stains from sandstone. The sandstone surface became brighter in color due to the beaching effect of hydrogen peroxide. The mixture, however, was not effective in removing oil stains from the marble and granite surfaces. AB57 solution, on the other hand, was very effective in cleaning

soot from sandstone. The method was less effective in removing soot and oil stains from the marble's surface. Residual salts of AB57 solution on the marble's surface had to be cleaned with water and after cleaning, however, the marble's surface became rough in appearance.

AB57 solution with carboxyl methyl cellulose poultice could remove soot very well from the surfaces of granite, marble and sandstone (as in order) but it was not as effective as AB57 solution using cotton swab sticks. One of the disadvantages of this method is that it was difficult to remove the dried carboxyl methyl cellulose film from the stone surfaces. In addition, the stone surfaces became slightly powdery due to the presence of residual salts from AB57 solution and had to be cleaned thoroughly with water. Oil stains cannot be removed completely using AB57 solution and carboxyl methyl cellulose poultice, and had to be cleaned further with AB57 solution and water using cotton swab sticks. The result of this cleaning method is a clean but rough marble surface due to the presence of some salt crystals remaining on the surface. Oil stains is still faintly visible. The marble's surface, however, appeared to be much cleaner than that cleaned using 0.5% Labolene in warm water. In the cases of sandstone and granite, the surfaces appeared almost as clean as the original but were slightly darker in color. Oil stains was removed well and there was little of it remaining on the sandstone and granite surfaces. As for the cleaning of soot and oil stains on marble, sandstone or granite, AB57 and paper pulp or Fullers' earth poultices was not as effective as AB57 and CMC poultice, except that the use of Fullers' earth poultice was more effective than CMC poultice in removing soot and oil stains from sandstone.

(2) Cleaning of Enamel Paint

Enamel paint stains on the surfaces of granite, marble and sandstone can be easily removed and cleaned using dichloromethane. It was very easy to remove enamel paint stains from the granite's surface as the paint came off in a layer, leaving only a very thin layer of paint on the surface. This thin layer of paint can be removed almost completely from the granite's surface using dichloromethane and the resulting surface appeared clean but slightly darker in color than the original. As for sandstone, dichloromethane tends to spread the paint during cleaning and most of the paint got trapped in the pores of the sandstone's surface. It was difficult to remove the paint completely from the pores, leaving the surface slightly reddish in color. In the case of marble, it was very easy to remove enamel paint stains from its surface, and after 15 minutes of cleaning, the marble's surface appeared as clean as that of the original.

Cleaning of paint stains using dichloromethane with Fullers' Earth poultice were not easy as the Fullers' earth tends to dry up very fast and cracked easily. It was also difficult to remove the clays completely from the sandstone's surface because the clays tend to stick to the pores of the sandstone as well as on the surfaces of the marble and granite. The clay poultice absorbed some of paint from the marble and sandstone surfaces (about 30%). Dichloromethane with Fullers' earth poultice, however, was not as effective as dichloromethane with cotton swab sticks in cleaning paint stains from marble and sandstone surfaces. The use of dichloromethane with Fullers' earth as poultice was very effective in removing paint from the granite's surface as it could remove almost 90% of the paint stains, which came off in a layer. Further cleaning with dichloromethane using

cotton swab sticks resulted in a much cleaner granite surface than that cleaned only with dichloromethane using cotton swab sticks (without the use of Fullers earth as poultice).

Ethyl alcohol cleaned and removed the enamel paint stains slowly from the surfaces of sandstone, granite, and marble (as in order) and it was not as effective as dichloromethane. After 15 minutes of cleaning, the paint stains were still covering the surface of the sandstone and some were stuck stubbornly to the pores of the sandstone surface. Red patches or spots of paint stains could still be seen on the surfaces of the marble and granite samples.

(3) Cleaning of Algae

Algae could be cleaned easily from the sandstone's surface with 0.5% Labolene in warm water. The use of ammonium:water (1:10 ratio) was very effective in removing and cleaning algae and the surface appeared cleaner and brighter than that cleaned with 0.5% Labolene in warm water. However, care should be exercised when using ammonium:water solution as it tends to remove very effectively the paint layer as well. AB57 solution was effective in removing algae but the result was not as good as that cleaned using ammonium and water. The main advantage of using AB57 solution in this cleaning test is that it removed less paint from the sandstone's surface compared to the other chemicals used in this study. Benzalkonium chloride was also tested and was found to be very effective in removing and cleaning algae. This chemical, however, removed the most amount of paint when compared to the other chemicals tested in this study. As such, care should be taken when using Benzalkonium chloride.

Conclusions

This study was carried out to compare the effectiveness of cleaning methods commonly used to clean and to remove soot, oil, paint and algae from stone artifacts made of marble, sandstone and granite. The result of this study revealed that there is no one best method that can be employed to clean soot, oil, paint or algae from marble, sandstone, and granite artifacts. Each of the methods tested in this study has its own risks and advantages on the different types of stone materials. For instance, a mixture of ammonium: water: hydrogen peroxide (1:1:1 ratio) would be the most effective method to remove soot and oil stains from sandstone but it was not effective on marble and granite. AB57 solution with CMC poultice, on the other hand, was very effective in cleaning soot and oil stains from marble, sandstone and granite but it was difficult to remove the CMC poultice and this method often leaves the stone surfaces rough with residual salts of AB57. If a thorough assessment of the effectiveness of the cleaning methods is to be made, the stone surfaces should be examined closely under the microscope and the levels of stains or salts should be determined before, during and after the process of cleaning. However, it is often not easy to meet the time, cost or space demands of such a study, especially during conservation in the field. This study employs simple tools and easily available chemicals and does not require a high level of scientific skills. The methods developed in this study are viable and practical alternatives to compare and to find the most effective ways to clean and to remove soot, oil, paint and algae from artifacts made of marble, sandstone, and granite.

Acknowledgements

This research was made possible with the help of a number of individuals and organizations. First of all, I am very grateful to the ASIA Fellows Program for providing the financial support and the selection committee for giving me the opportunity to do my training and research in conservation for 7 months in India. Dr. Lourdes Salvador, Ms Somkamol Chaiyavej, Ms Sasithara Sethanandha and all the staff of the Asia Fellows Program regional office in Bangkok have been most helpful and efficient in handling my travel, financial and logistical matters during my stay in India and in Bangkok. I owe special thanks to Dr. O. P. Agrawal, the Director-General of the Indian Council of Conservation Institutes, his wife Ms Usha Agrawal, and all the staff of INTACH Charles Wallace Institute of Conservation Training and Research, Lucknow for their kindness and help during my 3 months of research and stay in Lucknow, India. I would also like to acknowledge my gratitude to Dato' Professor Ishak Tamby Kechik, the former Vice Chancellor of Universiti Sains Malaysia and Dato' Professor Zuraina Majid, the director of the Centre For Archaeological Research Malaysia for granting me leave of absence from my work to undergo training and research in India.

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Appendix 1

Test 1: Cleaning Soot

(i) Cleaning of Soot with 0.5% Labolene in lukewarm water

Marble	Sandstone	Granite
5 minutes of cleaning	5 minutes of cleaning -soot was removed very easily. Oil stains was removed much better than that of marble. The surface appeared slightly darker than original color.	5 minutes of cleaning -soot was removed very easily. Oil stains was not removed completely. The color of the granite surface was slightly darker than the original color.
15 minutes of cleaning -more soot was removed and the surface appeared brighter and light grey in color. Oil stains could not be removed completely.	15 minutes of cleaning -more soot and oil stains were removed and the surface appeared brighter but darker than the original color. Some oil stains was still visible.	15 minutes of cleaning -more soot and oil stains were removed and the surface appeared slightly cleaner, brighter and closely similar to the original surface color.

Appendix 2

(ii) Cleaning of Soot with Water

Marble	Sandstone	Granite
5 minutes of cleaning -soot was easily removed. Oil stains was difficult to remove (dark layer). The surface appeared darker in color than that cleaned with 0.5% Labolene in warm water.	5 minutes of cleaning -soot was removed very easily. Some oil stains was removed but some still remained on the surface. The surface color was close to that cleaned with 0.5% Labolene in warm water.	5 minutes of cleaning -soot was easily removed .Oil stains was difficult to remove. The surface color appeared darker than that cleaned using 0.5% Labolene in warm water.
15 minutes of cleaning -more soot and oil stains were removed. Surface appeared brighter but darker (light grey) than the original surface color. Oil stains could not be removed completely.	15 minutes of cleaning -more soot and oil stains were removed. Surface color appeared slightly brighter but still darker in color than the original. Oil stains was still visible.	15 minutes of cleaning -more soot and oil were removed. The color of cleaned granite's surface appeared slightly brighter than the original surface color.

Appendix 3

(iii) Cleaning of Soot with ammonia: water: hydrogen peroxide (1:1:1 ratio)

Marble	Sandstone	Granite
5 minutes of cleaning -soot was removed easily but it was not easy to remove the oil stains. The surface appeared as clean as that cleaned using 0.5% Labolene in warm water or with water only.	5 minutes of cleaning -soot was removed very easily and the surface appeared very clean and brighter red in color. The surface was cleaned better than using 0.5% Labolene in warm water or water alone.	5 minutes of cleaning -soot and oil stains were removed well but some dark stains remained on the surface. The surface appeared darker than the original. It was also slightly darker than that cleaned with 0.5% Labolene in warm water but was lighter in color than that cleaned with water only.
15 minutes of cleaning -more soot and oil stains were removed but not completely. The surface appeared brighter but darker (light grey) than the original surface color.	15 minutes of cleaning -more soot and oil stains were removed. The surface became brighter and more whitish in color, possibly due to the bleaching effects of hydrogen peroxide.	15 minutes of cleaning -more soot and oil stains were removed and the surface was darker than that cleaned with 0.5% Labolene in warm water or with water only.

Appendix 4

(iv) Cleaning and Removal of Soot with 5% dichloromethane in ethanol

Marble	Sandstone	Granite
5 minutes of cleaning -soot was removed well but it was not as easy as with 0.5% Labolene in warm water. The surface color appeared slightly darker than that cleaned with 0.5% Labolene in warm water. Oil stain was removed almost completely.	5 minutes of cleaning -soot was removed very easily but the soot was spread during cleaning. The surface had black stains due to soot trapped in the pores of the sandstone. Some oil stains was removed but not completely. The result was closely similar to that cleaned with 0.5% Labolene in warm water.	5 minutes of cleaning -soot was removed well but the color of surface became darker than that cleaned with 0.5% Labolene in warm water. Oil stains was removed almost completely.
15 minutes of cleaning -more soot and oil stains were removed. The surface appeared brighter (light grey) and darker than the original surface color. The surface was as clean as that cleaned with 0.5% Labolene in warm water.	15 minutes of cleaning -more soot and oil stains were removed but some soot was still trapped in the pores of the sandstone. Oil stains can still be seen on the surface.	15 minutes of cleaning -more soot and oil stains were removed but the resulting color was still darker than that cleaned with 0.5% Labolene in warm water.

Appendix 5

(iv) Cleaning and Removal of Soot with "AB57" Solution and Water.

Marble	Sandstone	Granite
5 minutes of cleaning -soot and oil stains were removed well but not as easy as with 0.5% Labolene in warm water. Some salts crystals remained after cleaning but they can be washed away with water. The surface, however, became more rough in texture.	5 minutes of cleaning -soot was very easily removed but oil stains was still visible. The surface became brighter but still darker than the original color (dark red). Salt crystals from the cleaning solution had to be washed away with water.	5 minutes of cleaning -soot was removed very well but appeared slightly darker in color than the original surface color. It can clean as well as 0.5% Labolene in warm water. Salt crystals from the AB57 solution had to be washed away with water.
15 minutes of cleaning -more soot and oil stains were removed but the surface appeared darker than the original color and was not as clean as that cleaned with 0.5% Labolene in warm water. Deposits of salt crystals had to be washed off with water, leaving the surface texture rougher. Oil stains was still visible on the surface.	15 minutes of cleaning -more soot and oil stains were removed but surface color still appeared darker than the original. Some soot was trapped in the pores of the sandstone and oil stains was still visible.	15 minutes of cleaning -more soot and oil stains were removed. The surface appeared lighter in color but was still darker than the original.

Appendix 6

(v) Cleaning and Removal of Soot with "AB57", CMC poultice and Water.

Marble	Sandstone	Granite
-much of the CMC poultice can be removed easily but some CMC film was stuck on the surface and had to be scrubbed away with a spatula. Soot was removed but not as well as with cotton swab sticks. The residual salts had to be washed off with water. Oil stains was visible. More soot and oil stains were removed when cleaned with water and cotton swab sticks. The surface appeared cleaned but rough crystals of salts can still be easily seen. Oil stains was faintly visible. The use of CMC poultice can clean better than 0.5% Labolene in warm water but it was not as good as dichloromethane.	-CMC film was easily removed (much easier than on the surface of marble). Soot was not well removed as most of the soot was trapped in the pores. Oil stains was visible and was not well removed. More soot and oil stains can be removed with water and cotton swab sticks. The surface appeared to be cleaned (almost similar to the original color but darker). Oil stains was removed well but a faint stain can still be seen (this is the best method so far to remove oil from sandstone)	-CMC film was removed easily but some CMC was still stuck stubbornly to the granite's surface. Oil stain cannot be removed very well. The surface became powdery and had to be cleaned with water to remove the CMC film and salts. The surface appeared cleaned like the original but it was darker in color. Oil stain was still faintly visible.

Appendix 7

(vi) Cleaning and Removal of Soot with "AB57", Paper Pulp Poultice and Water.

Marble	Sandstone	Granite
-it was very easy to remove the paper pulp poultice. Most soot and oil stains were still stuck onto the surface. More soot can be removed by cleaning with water. The surface became clean but oil stains still remained as a dark layer and was difficult to remove with water.	-it was very easy to remove the paper pulp poultice. Most of the oil stains was still visible. Some soot was still stuck to the sandstone surface. Cleaning with water removed most of the soot and some oil stains as well. The surface has dark stains of soot trapped in pores and was difficult to remove with water. A faint layer of oil stains still remained on the surface. The use of paper pulp poultice however could not clean soot as well as CMC poultice.	-it was very easy to remove the paper pulp poultice. Most of the oil stains still remained on the surface. Most soot was still stuck on the surface. Washing with water removed most of the soot and some oil stains as well. The surface appeared as clean as that cleaned with CMC poultice but the oil stains left a dark patch on the surface. The use of paper pulp poultice however could not clean as well as CMC poultice.

Appendix 8

(vii) Cleaning and Removal of Soot with "AB57", Fullers' Earth Poultice and Water.

Marble	Sandstone	Granite
-Fullers' earth clay poultice dried up easily and cracked. It was very easy to remove the clays but the clays tend to stick to the surface as a thin film. Oil stains was still visible. Much soot was removed during cleaning with water but oil stains remained stuck onto the surface and was difficult to remove with water. The surface appeared slightly darker than the original surface color.	-Fullers' earth/clays was easily removed from the stone surface. Some clays was stuck as a thin film onto the stone surface and was difficult to remove. Soot was also stuck onto the pores of sandstone. Washing with water removed most of the soot and oil stains. The surface appeared clean and the result was better than on marble and much better than when CMC poultice was used – the surface became more clean and brighter but faint stains of oil still remained.	-clays was easily removed but cracks were noted. A thin film of clays remained stuck onto the stone surface. Oil stains can be seen easily and could not be removed by the clay poultice. Washing with water removed most of the soot and the oil stains, leaving the surface as clean as that cleaned with CMC poultice. Oil stains, however, still remained as a dark layer and was not as clean as that treated with CMC poultice but it was much better than that treated with paper pulp poultice.

Appendix 9

Test 2: Cleaning of Enamel Paint

(i) Cleaning and Removal of Red Enamel paint with Dichloromethane

Marble	Sandstone	Granite
5 minutes: -it was very easy to remove paint stains from the surface. Some paint layers were left on the surface, making it reddish in color. 15 minutes: -more paint was removed on continuous cleaning. The surface became almost as clean as the original surface.	5 minutes: -it was very easy to remove the paint stains. However, the paint stains tend to spread during cleaning and covered the entire surface. Most of the paint was trapped in the pores of the sandstone, making it difficult to remove the paint. 15 minutes: -much of the paint stains was removed on continued cleaning. It was more difficult to remove paint stains on sandstone than on marble as the paint got trapped in the sandstone pores. The surface color became slightly reddish in color with paint.	5 minutes: -it was most easy to remove paint stains. Much of the paint stains was removed in a layer. A very thin layer of reddish paint was left. The surface became faint reddish white in color. 15 minutes: -more paint stains was removed on continued cleaning. Very little paint was left and the surface appeared cleaned but the color was darker than the original.

Appendix 10

(ii) Cleaning and Removal of Red Enamel paint with Dichloromethane and Fullers' Earth Poultice

Marble	Sandstone	Granite
5 minutes: -the clay poultice dried up very fast even under a plastic sheet cover. The clay absorbed some of the paint on drying. The clays can be removed with a wooden spatula and some paint layer (30%) can be peeled off easily while the rest were stuck onto the marble's surface.	5 minutes: -the clay poultice also dried up very fast under a plastic sheet cover. The clay poultice absorbed some of the paint on drying. After the removal of the poultice with wooden skewers, a lighter red color of paint remained on surface.	5 minutes: -the clay poultice dried up very fast under a plastic sheet. Some paint was absorbed during the drying of the clays. The clays can be removed with a wooden skewer and layers of paint came off easily (90%), exposing the black granite surface color.
15 minutes: -more paint stains was removed on continued cleaning. It was easy to clean the rest of paint stains with dichloromethane using cotton swab sticks but the results was not as clean as that cleaned using only cotton swab stick.	15 minutes: -further cleaning with dichloromethane and cotton swab sticks removed more red paint but some paint got struck to the pores and was very difficult to remove. Better results were achieved using only cotton swab sticks instead of clay poultice.	15 minutes: -further cleaning with dichloromethane and cotton swab sticks can remove the rest of the paint stains easily. The surface became cleaner than that cleaned using cotton swab sticks only.

Appendix 11

(iii) Cleaning and Removal of Red Enamel paint with Ethyl Alcohol

Marble	Sandstone	Granite
5 minutes: -paint stains can be removed well but it was not as effective as on granite. Some paint was still left on the surface, about 20-30% was stuck stubbornly to the stone surface. 15 minutes: -more paint stains was removed on continued cleaning. The surface still has patches of red paint, particularly in the pores. The stone surface was not clean and appeared reddish in color.	5 minutes: -paint stains was removed slowly but it was not as effective as on marble. Almost 100% of paint still covered the surface in a thin coating. It was difficult to remove paint using this solvent on the sandstone's surface. 15 minutes: -the whole surface was still red, covered by a very thin layer of paint. Some paint was stuck stubbornly to the pores and the surface appeared rough in texture.	5 minutes: -paint stains can be removed well but it was slower and was not as effective as dichloromethane. All the paint layers were removed but spots of reddish paint stains were left behind, leaving the surface appeared light reddish in color. 15 minutes: -more paint stains was removed on continued cleaning. The surface still has red spots of paint and was slightly not as clean as that cleaned using dichloromethane.

Appendix 12

Test 3: Cleaning of Algae

Chemicals Used	5 minutes	10 minutes
1) 0.5% Labolene in warm water	-this chemical removed algae well but was not very effective as it tends to spread the algae on the stone surface making it greenish and darker in color.	-more algae was removed on continued cleaning, making the stone surface brighter in color. Further cleaning also began to expose the paint layer but it could not remove the algae completely.
2) Ammonium: water (1:10 ratio)	-this chemical removed algae very well. The result is cleaner when compared to that cleaned using 0.5% Labolene in warm water as it does not spread the much of the algae on the stone surface. The surface appeared brighter and the paint layer was exposed.	-more algae was removed on continued cleaning. The surface was clean and the paint layer was exposed completely. Some paint, however, was also removed during cleaning.
3) AB57 solution	-this chemical removed the algae very well but was slightly not as good (little less clean) as that cleaned using ammonium and water.	-more algae was removed on further cleaning and some paint was removed during cleaning.
4) Bezalkonium chloride	-this chemical removed algae very well but it also removed the paint and stained the surface reddish with the paint.	-further cleaning removed more algae but the greenish color of the algae was still visible on the stone surface. It also removed most of the paint layers when compared to the other chemicals used.