CHAPTER VI

HEAT TREATMENT EXPERIMENT

6.1 Introduction

Songea corundums usually reveal two main characters that strongly effect their values. Firstly, their colors are often a mixture of multiple colors, which give strange shades like violet, purplish red, yellowish green etc; besides they also contain color patch and zoning. Secondly, clarity of Songea corundum is often low; it may be caused by silky inclusions that usually occur. Both characters directly lower the value of Songea corundum. Heat treatment is a conventional method to improve quality of corundum. Heat treatment can improve the stone clarity by eliminating silky inclusions and intensify or lighten some color shades, particularly yellow and blue (Themelis, 1992). Hence, heating experiments were set to find potential and optimum condition of treatment for Songea stones.

6.2 Procedure

The experiments were carried out using Linn electrical furnace (model HT1800 VAC Bottom Loader) belonging to Department of Geology, Faculty of Science, Chulalongkorn University (Figure 6.1) According to experiments reported by Pattamalai (2002); Sakkaravej (2004) two conditions of heating were set at 1,200^{o}C with 3 hours soaking time under oxidizing environment and at 1,400^{o}C with 3 hours soaking time under reducing condition were the best conditions. Both experiments were controlled at the increasing and decreasing rates of 4^{o}C per minute.

Figure 6.1 The furnace used in this experiment is Linn electrical furnace model HT 1800 Plus VAC Bottom Loader (Chulalongkorn University).

6.3 Results of the experiment

Oxidizing experiment was aimed at removing blue component from the stones; however, sixteen samples representing all color varieties were selected for the experiment. Red and colorless variety shows only slightly change in color between before and after heating (Figure 6.9). Actually, they seem likely that heat did not effect on color of both varieties. The other varieties show loss of blue components quite clearly after heating (Figure 6.2). Blue variety appears to turn pale green, which yellow shade may be slightly produced during the heating. All samples in purple variety are obvious changed to pink stones. Yellow variety is mostly lost their colors and likely turns colorless (Figure 6.2).

Reducing experiment was carried out with the intention to intensify blue component. All color varieties were selected with the total of sixteen samples for the experiment. Results are conclusively worst than expected. Blue components in red, purple and blue variety are mostly gone and the stones mostly yield colors similar to those obtained under oxidizing conditions. Red variety becomes darker than before, while colorless variety appears to have no change (Figure 6.3).

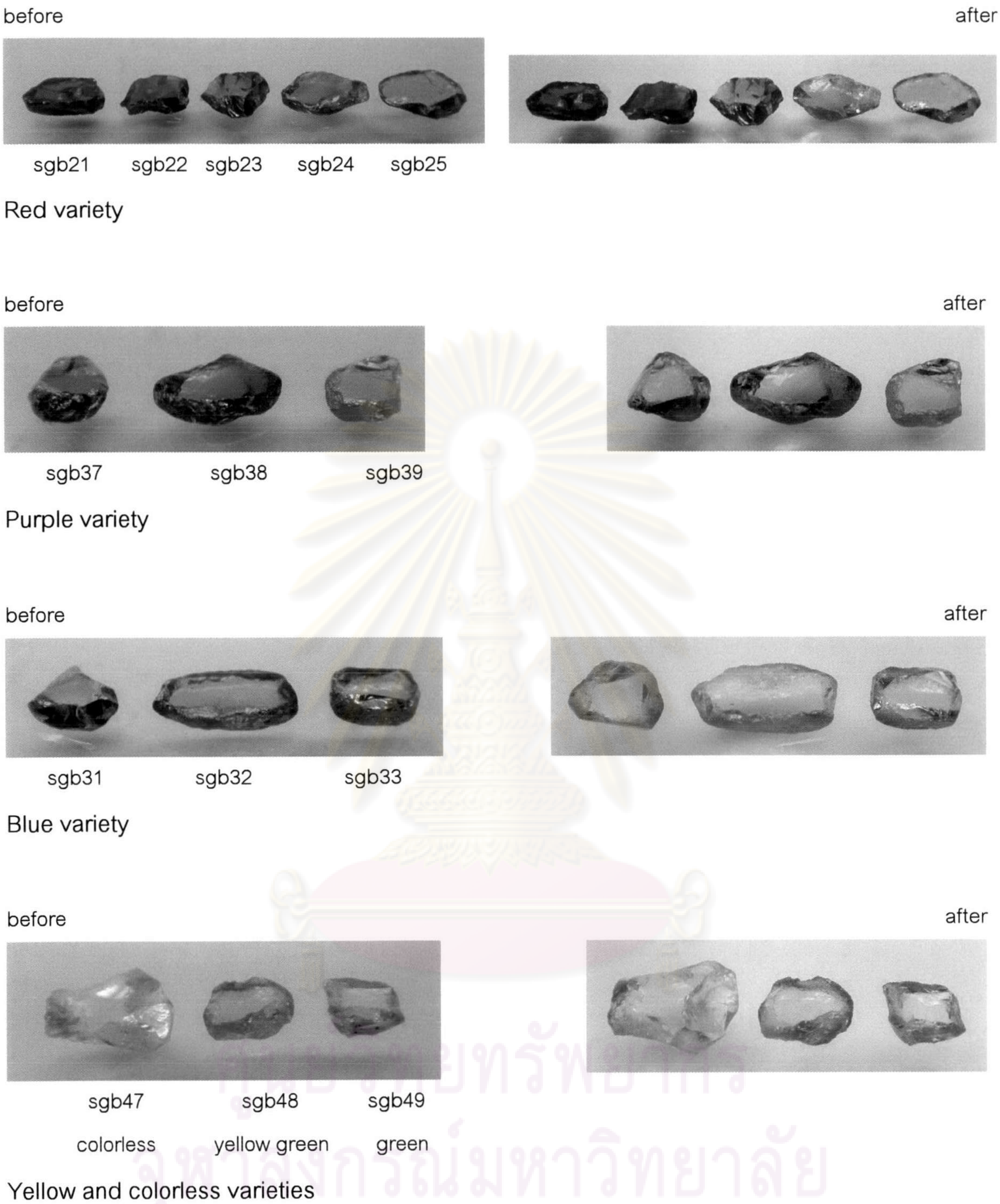

Figure 6.2 Songea corundums before and after heating at 1200°C in oxidizing condition.

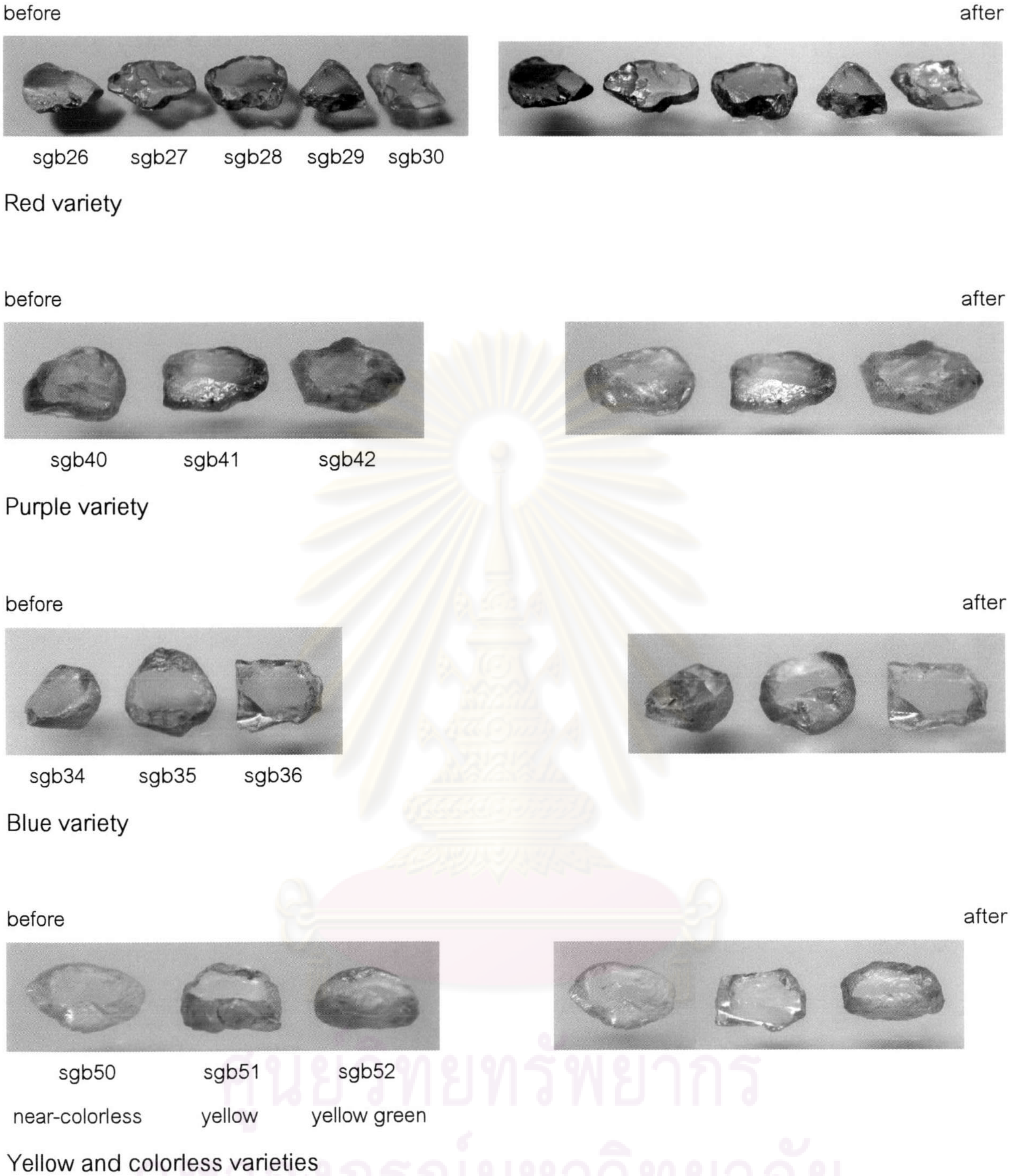

Figure 6.3 All sample varieties of Songea corundum showing initial colors and colors after heating experiment at 1,400^{o}C under reducing environment.

In conclusion, Songea corundums are difficult to be heat treated. Reason of this aspect may be explained by their trace compositions. As reported in Chapter 5, Songea corundums contain rather high Fe content and have their Mg:Ti atomic ratios close to 1:1. Haeger (2001) suggested color models of corundum when heat treated at high temperatures under oxidizing environment (Figure 6.4) and reducing condition (Figure 6.5). These colors are related to trace compositions of Mg, Fe and Ti. Ternary plots between Mg, Fe and Ti in Figures 6.4 and 6.5 indicate clearly that colors would be colorless along compositional line 1:1 of Mg:Ti ratio, besides colorless will also be extended towards higher Mg contents, if the stone is heated in reducing environment (Figure 6.12). Therefore, Songea corundums tend to lose their colors after heating at high temperature either in oxidizing or reducing environment. However, red and purple varieties can be improved their red shade by getting rid of other shades. Although Haeger (2001) suggested that Cr-bearing corundum with 1:1 of Mg:Ti should give red color after heating in both reducing and oxidizing atmosphere (Figures 6.6 to 6.7), they would be recommended, based on result of this study, to be treated at lower temperature (1,200°C) in oxidizing atmosphere.

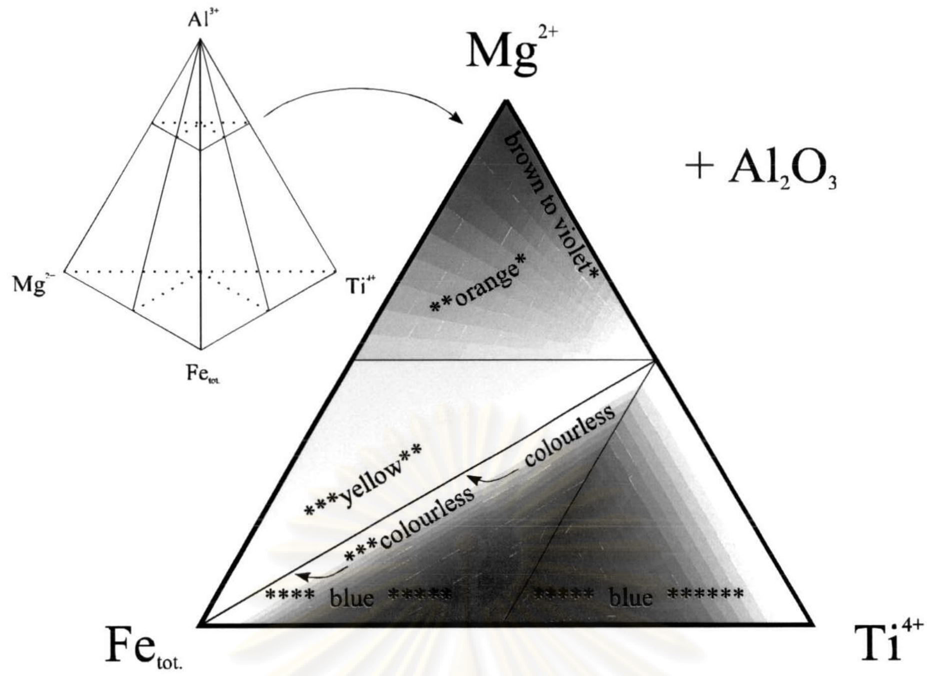

Figure 6.4 Model of sapphires heat treated at 1850°C in oxidizing atmospheres (Haeger, 2001).

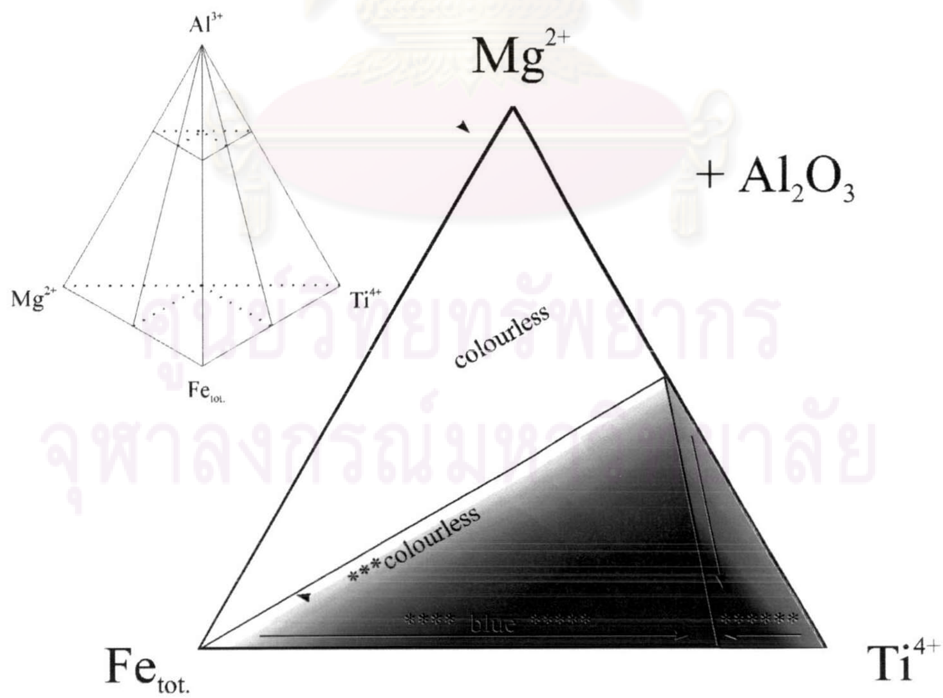

Figure 6.5 Model of sapphires heat treated at 1750°C in reducing atmospheres (Haeger, 2001).

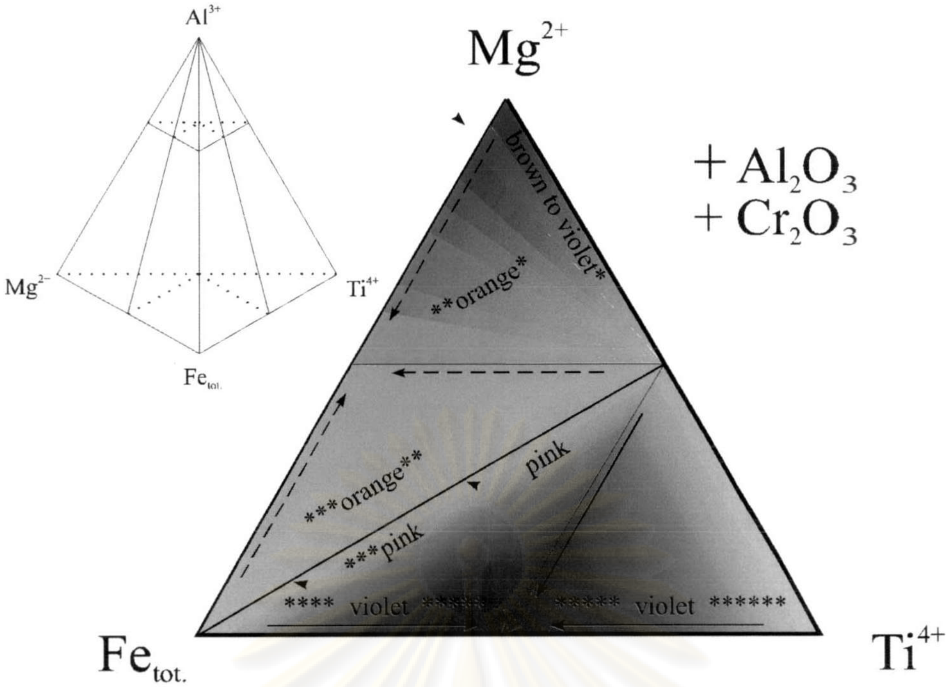

Figure 6.6 Model of corundums heat treated at 1850°C in oxidizing atmospheres (Haeger, 2001).

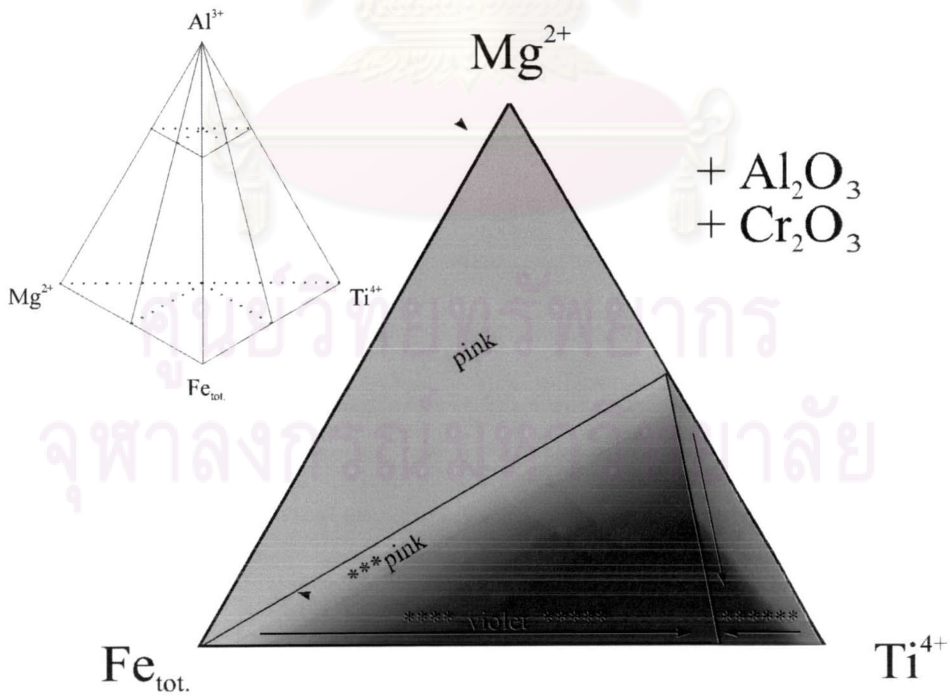

Figure 6.7 Model of corundums heat treated at 1750°C in reducing atmospheres (Haeger, 2001).